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Helen Wareham

Does good practice quality equate to earlier cancer stage at diagnosis?

Abstract

The early diagnosis of cancer is a priority within the UK, with GPs being identified as playing a key role. The aim of this research was to look at the relationship between GP practice quality and cancer stage at diagnosis, for breast and colorectal cancer, within the North East of England.

This was done by utilising existing healthcare databases, with data being obtained from the National Health Service (NHS) information centre, public health observatories and Northern and Yorkshire Cancer Registry and Information Service. Patient data was from between 2006-2008 with n = 13,610 cases of breast cancer and n = 11,606 cases of colorectal cancer. The data was combined and a range of analyses conducted to investigate the potential relationship between GP practice quality and a patient's cancer stage at diagnosis.

For breast cancer there was a significant relationship between GP practice quality and cancer stage in both multi-level and base outcome regression analyses. A range of specific variables, many of which were related to patient experience, were found to have a significant effect upon breast cancer stage. Patient age and level of income were also found to have a significant effect upon breast cancer stage.

For colorectal cancer no association was found in multi-level analysis but a significant association was found between cancer stage and variables related to patient experience, such as a patient's ability to see a doctor within two days. Patients of working age (18-64) compared to retirement age (65+), were found to be more likely to have a more advanced cancer stage at diagnosis, as were patients with low income.

In summary, significant associations were found between measures of GP practice quality and patient cancer stage at diagnosis, specifically GP variables related to patient experience. This association suggests that higher quality of practice may increase the likelihood of being diagnosed with earlier stage of cancer. The limitations of this research are highlighted and directions for future research projects and healthcare policy are discussed and outlined.

Does good practice quality equate to earlier cancer stage at diagnosis?

Helen Wareham

Thesis submitted for the degree of Doctor of Philosophy, School of Medicine, Pharmacy and Health, Durham University

2013

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Acknowledgements

The first thanks must go to my supervisors; Prof. Greg Rubin, Dr. Jean Adams, and Prof. John Wilkinson. Greg especially deserves a special thanks, as I'm sure I have caused no end of concern and stress, but he has remained patient with me.

The School of Medicine and Health at Durham University and FUSE (The Centre for Translational Research in Public Health) for providing me with this opportunity of study and support when needed.

The data used for this project has come from a range of institutions, employees of which were most helpful and accommodating; NYCRIS, ERPHO & NEPHO. The NIGB office and Sunderland NHS REC were also very helpful with the range of enquiries and questions I had regarding ethics. My thanks also go to them.

This has without a doubt been one of the most difficult and biggest struggles and I could not have maintained my sanity without the help of the following;

The many occupants of E113a and over the 'wall' in E113, for providing a wonderful mix of both academic support, solutions, advice, and sheer entertainment. Special thanks to: Anna Christie, Christina Dobson, Charlotte Kitchen, Rachel Stocker and Patrick Welsh.

Towards the end of this thesis I began working for Durham University museums and libraries. The staff have been amazing and supportive and I thank them for that.

The entertaining staff in the Bill Bryson Library café and café Aroma on Queen's campus for supplying me with copious amounts of coffee.

I have had the distinct privilege and honour to have been a part of Durham University Nightline. Giving up a night's sleep is a small sacrifice to be there for someone when they need it, and no matter how many nights I have given up I have gained so much. From callers who have pushed and tested my beliefs and view of the world, to the support I have received and found in the other volunteers. I cannot adequately express my gratitude.

Most important thanks goes to my family. My parents have always been an unwavering pillar of support in every conceivable way, my sister Laura is equally amazing in her services, and my soon to be wife Kirsty has endured my numerous freak outs, down days, and mood swings with a knowing smile and an unending supply of motivational speeches. Thank you.

For my parents (Christine and Dave), Laura, Kirsty and absent friends.

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1. Chapter 1 – Introduction

The primary aim of this thesis was to examine the potential relationship between GP practice quality and cancer stage at diagnosis. The rationale for this being that diagnosis of cancer at a less advanced stage is shown to improve patients' outcomes (Brenner *et al.*, 2012, Coleman *et al.*, 2003, Richards, 2007, Verdecchia *et al.*, 2007b). Many countries have invested in and developed early detection initiatives and programmes, for example, in the UK the National Awareness and Early Diagnosis Initiative (NAEDI) (Richards, 2009). GPs have been identified as playing a key role in early detection and diagnosis, the most common diagnostic pathway is through patients presenting their symptoms to a GP and the GP referring suspected cancer cases to specialists.

While inequalities in patient demographics and their impact on cancer diagnosis and outcomes is well documented (Cuthbertson *et al.*, 2009, Collerton *et al.*, 2009), there is a suggestion that GP factors may contribute to delays in diagnosis (Barrett *et al.*, 2010). Equally with the change in economic climate, funding and public service cuts and the growing issue of global health, there is a greater pressure on GPs to deliver good and accurate service.

It was hypothesised, therefore, that GPs and practices that perform well in assessments of their quality standards would refer patients with suspected cancer earlier and that those diagnosed with cancer would have earlier stage disease.

Within the UK GPs can partake in a national quality scheme, the Quality and Outcomes Framework (QOF), which measures their quality of service not just in a clinical capacity but also on an organisational and customer satisfaction level. Schemes such as these mean that large databases regarding and containing health data are being developed and created which provide a unique and desirable source of data for research.

Part of the aim of this research was to utilise existing health datasets, as this research was funded by the Economic and Social Research Council (ESRC) as part of their e-health initiative. The ESRC's aim was to build capacity for future research using personalised electronic health records, with a particular aim to link and combine existing datasets.

This particular studentship was to have a focus on cancer in primary care and was obtained through a successful bid by FUSE, the UKCRC-funded Centre for Translational Research in Public Health which was based at Durham University but jointly supervised with Newcastle University.

The aim and objective of this thesis are therefore as follows:

- The aim of this project was to investigate whether there was a relationship between GP practice quality and patient cancer stage at diagnosis.
- The objective of this project was to use a secondary data analysis method by utilising and obtaining data from existing health databases in order to analyse if there was a potential link between GP practice quality and patient cancer stage at diagnosis in breast and colorectal cancer in the North East region of England.

The chapters of this thesis are as follows:

Chapter 2: Background literature

This chapter provides an overview of literature in the area of this thesis. An explanation of cancer and the scale of the problem, both within the UK and globally, is given before exploring the research surrounding diagnosis and the associated delays and barriers. It summarises the current economic climate and the impact of the recent change in government on the National Health Service (NHS) in England. The current process of cancer diagnoses in England, how it is identified and the role GPs have to play in diagnosis

is outlined along with the quality measures that have and are currently being used to assess GP practice quality. Finally the study's primary aim and wider secondary aims are outlined.

Chapter 3: Systematic literature review

In this chapter an overview of quality of care within primary care is provided; how quality is defined, issues with the definitions, how it has been measured, how it is measured now and the problems of those approaches. The way in which quality has been measured and assessed has been widely debated, therefore it seemed pertinent to conduct a systematic review of the literature in this area with the aim to clarify and identify gaps within the current research. A search criteria was developed and a systematic search conducted with the aid of a second reviewer before a narrative analysis was conducted on the final selected papers.

Chapter 4: Methods

This thesis used existing healthcare databases as the source of information and data. This type of secondary data analysis is a more recent method, with little previous research utilising and combining the particular resources used in this study. As a result this chapter discusses the choices and reasons for selecting certain databases, the unique and specific challenges of ethics and obtaining the data as well as outlining the planned analysis approach.

Chapter 5: Results

In this chapter the results of the analysis are reported, with the two cancer types being reported separately. For each, the findings are outlined from the distributions within each variable through each stage of analysis.

Chapter 6: Discussion

The key findings of the research are summarised and discussed within the context of current and previous research. What they add to the current knowledge and understanding in this area and where conflicts with previous findings lay. How this research fits into the current and evolving climate of healthcare in England is discussed, along with comments on its impact on the current changes along with recommendations for changes within healthcare based on this study's findings.

Chapter 7: Conclusions

A summary of the study is provided, along with the strengths and weaknesses of this research. Personal reflections on conducting this project and what changes would be made given the opportunity to repeat the experience, along with suggestions for the direction of future research in this area and/or as a continuation of this project.

2. Chapter 2 – Background Literature

This chapter contains a general literature review and outlines the current climate surrounding cancer diagnosis and GPs. Starting with a brief outline of what cancer is, its causes and prevalence, it then goes on to discuss early detection and its importance in cancer diagnosis and survival outcomes and the barriers that have been found to delay that process. Models that have been developed to explain the process of delay and associated factors are discussed before an explanation of the different diagnostic pathways that patients can take within the English health care system, is outlined.

These pathways are then put into the context of the current climate; the impact of recent economic and political events, such as the recession and future NHS reforms are discussed and finally a brief overview of quality of care within primary care is included, this is however discussed more in-depth in chapter 3 (systematic literature review), before the primary research aim and subsidiary aims are outlined.

2. 1. What is cancer?

Cancer is a generic term for a large group of diseases that can affect any part of the body and is characterised by the uncontrolled growth and spread of cells. What causes cancer is still not entirely known or understood, but it is clear that the interaction between a person's genetic traits and external agents are important. These external factors include a range of known carcinogens, such as ultraviolet and ionizing radiation, asbestos, aflatoxin and arsenic. Other risk factors associated with cancer include; leading an unhealthy life style (poor diet and exercise), tobacco and alcohol use and infections from viruses such as hepatitis and human papilloma virus.

Ageing is a known factor in the development of cancer, as age increases the risk and also the incidence of cancer. This is thought to be most likely due to a 'build-up' effect, the accumulation of external risk factors combined with the decrease in cell repair efficiency as a person ages.

2. 1. 1. Most common cancers

Worldwide the most common cancers are; lung, stomach, liver, colon and breast. However, the incidence differs between men and women, in particular breast predominantly affect females with a low percentage of males being affected. Within the UK the most common cancers differ slightly with breast, lung, colorectal and prostate being the four most common. Between males and females both lung and colorectal are common in both groups but in males prostate is the most common and in females, breast (Rutherford *et al.*, 2013, Cancer Research UK, 2013).

2. 1. 2. Prevalence of cancer

Worldwide cancer is a leading cause of death, accounting for around 7.6 million deaths annually and it is projected that by 2030 these will rise to over 13.1 million. Within the UK in 2009 there were 156,090 deaths from cancer and it is the second highest cause of death in the UK, second to circulatory diseases (Cancer Research UK, 2013, Office of National Statistics, 2012). There are approximately 309,527 new cases of cancer diagnosed each year in the UK (Cancer Research UK, 2013).

2. 1. 3. Ageing

The proportion of global populations aged over 60 years is rising rapidly, by 2050 the estimate is that one third of the global population will be aged 60 and over (United Nations, 2007). In the UK this is of particular concern, as the current retirement age in the UK is 65 and 10 million people within the UK population are 65 and over (this equates to 1 in 6 people). In the UK, between 2006-2008, 89% of newly diagnosed cancer cases were in people aged 50+. 36% were in people aged 75+, the highest cancer incidence rate in any age group per 100,000 (Boreham *et al.*, 2002). The current life expectancy for a child born today is over 85 years old and at present in those aged 85+, almost a quarter (23.9%) have been diagnosed with some type of cancer (Collerton *et al.*, 2009).

2. 1. 4. Other factors influencing cancer trends

Certain factors have been identified which, while they do not necessarily cause or directly contribute to the development of cancer have been found to either contribute to an increased likelihood of developing cancer or influence patient diagnosis and treatment. In particular age, sex, ethnic origin, geography and socioeconomic status have been identified as factors which have an influence (Downing *et al.*, 2007b, Delamothe, 2008,

Conway *et al.*, 2007, Cuthbertson *et al.*, 2009). The All Party Parliamentary Group On Cancer in their 2009 report on cancer inequalities support this and in addition highlight the fact that disability, sexual orientation and cancer type can also have an impact.

2. 2. Pathways to cancer diagnosis in England

All residents in the UK are meant to be registered with a local GP practice or surgery in order to receive access to health services. GPs are therefore, generally, the first point of contact within the health service. A patient will present their symptoms to a GP to be treated or referred on, as a result GPs act as gatekeepers to specialist care and play a vital role in the diagnosis and early detection of cancer.

In the case of cancer there are two basic diagnostic pathways that patients will receive a diagnosis through; symptomatic and asymptomatic.

2. 2. 1. Symptomatic/Referral

When a GP is presented with symptoms by a patient, which they suspect to be cancer, a referral is usually made to a specialist in secondary care for the relevant diagnostic tests to be carried out and assessed. These referrals can take time, depending on the time and resource constraints of the relevant hospital or health care facility/department. Research such as the EUROCARE studies have shown differences between European countries in cancer survival, and these have been attributed to differences in time to diagnosis (Møller *et al.*, 2009, Sant *et al.*, 2009, Verdecchia *et al.*, 2007a, Richards, 2007). In 1997 the two week referral (TWR) was introduced to reduce the waiting time for referrals, if a GP suspected a cancer then they could make an urgent referral and the target is for the patient to be seen by a specialist within two weeks.

Presentations and symptom identification is a problem for GPs in tackling cancer. With more than 200 different types of cancer there are a vast range of symptoms and factors which affect their presentation. In particular certain cancers, such as breast can present with a clear set of symptoms such as a breast lump and/or pain, and there are clear screening and diagnostic tests which can be used to achieve a diagnosis, such as a mammogram or biopsy. Therefore these cancers can potentially be identified, diagnosed and treated quickly resulting in good health outcomes and survival. However, there are equally a number of cancers which do not have clear symptoms. For example, Barrett *et al.* (2010) identified that there is no validated screening test for ovarian cancer and therefore these cases present primarily through primary care as symptomatic cases, similarly in pancreatic cancer symptoms are vague and can be easily interpreted and attributed to a different health problem, such as back pain.

This can make it difficult to identify which cases are appropriate for the two week referral. However, to aid GPs identification as to whether a patient's symptoms should be urgently referred on the TWR pathway, a series of guidelines based on 'red flag' symptoms have been developed and are regularly updated. These red flag symptoms can also identify when to use intrusive diagnostic procedures, e.g. in cases such as colorectal cancer where it is difficult to identify and diagnose without the use of invasive procedures such as endoscopies (Jones *et al.*, 2007, Hamilton *et al.*, 2009, Hamilton *et al.*, 2005, Jones *et al.*, 2009).

The TWR scheme has been met with a mixed response and varied success (Jones *et al.*, 2001, Barwick *et al.*, 2004, Cornford *et al.*, 2004, Haikel *et al.*, 2011, Potter *et al.*, 2007). While, as highlighted above, certain cancers such as breast have benefitted from the system in comparison to other cancer types, the introduction of TWR/urgent referrals has created a strain on health care resources. Hospital departments, in an effort to meet

targets have reported problems with trying to meet the demand, with some reporting seeing double the number of referrals each year. Equally some research has indicated that despite increases in the number of referrals, seen there has been no improvement in the proportion of earlier stage cancers diagnosed (McKie *et al.*, 2008).

It should be noted that there are alternatives to a GP referral via this pathway. Patients could, for example, be admitted to hospital as an emergency admission because their symptoms are so severe, and then receive a diagnosis this way, thereby by-passing their GP and any primary care involvement in the diagnosis. Emergency presentations are not uncommon and vary between cancer types, for example, Raine *et al.* (2010) reported finding an average rate of 15% for breast cancer emergency hospital admissions, while lung cancer was as high as 50%. The National Cancer Intelligence Network has reported an average 25% rate of emergency hospital admissions for all cancers and Bottle *et al.* (Bottle *et al.*, 2012) recently reported finding a 21.9% rate. Higher rates of emergency admission to hospital for cancer are generally viewed as an indicator of poor quality within the local area/Primary Care Trust (PCT) (Downing *et al.*, 2007b, Forrest *et al.*, 2014). Cancers diagnosed through emergency admissions are also more likely to be at a more advanced stage (Brewster *et al.*, 2011, Downing *et al.*, 2007b).

2. 2. 2. Asymptomatic

In the asymptomatic pathway patients haven't presented or experienced any symptoms to their GP. Patients are called to, or participate in, a cancer screening programme or initiative which has then detected the cancer. Currently there are three cancer screening programmes run by the NHS in England:

1. Breast - the NHS Breast Screening Programme invites all women between the ages of 50 and 70 for routine mammograms every three years. Around 1.5 million women are screened every year. It is important to highlight that this screening programme is conducted by and at screening units, not by GPs and their practice; however GPs do issue reminders if patients have not attended when invited. (http://www.cancerscreening.nhs.uk/breastscreen/index.html)
2. Cervical – the NHS Cervical Screening Programme; while a major part of its aim and goal is to identify cancer it is not a specific screening programme for cancer, rather it detects abnormalities in the cervix which could lead to cancer. All women between the ages of 25 – 64 are eligible for screening every 3-5 years, with over 3 million women being screened each year. (http://www.cancerscreening.nhs.uk/cervical/index.html)
3. Bowel – during this research the NHS Bowel Screening Programme was a new initiative that has now been rolled out across England. The programme will screen both men and women aged 60 – 69, increasing to 74 in the near future. (http://www.cancerscreening.nhs.uk/bowel/index.html)

Screening programmes for other types of cancer have been suggested, such as routine chest x-rays for lung cancer; however, such initiatives and programmes are either not cost effective or the validity of the test is not sufficient to warrant a national programme (Whynes, 2008).

Patients can also be diagnosed through other asymptomatic routes. In the UK the majority of health care is provided by the NHS but private health care is available at a cost. Annual health checks can include a variety of diagnostic procedures which could identify a cancer without the patient having presented any symptoms, for example it is not uncommon for chest x-rays or MRI scans to be used in health checks. The discovery of a

cancer during health care treatment for another health issue is yet another avenue. For example, the discovery of breast cancers during cosmetic procedures, such as breast augmentation.

There are limitations to both pathways. The asymptomatic pathway is limited because not all types of cancer can be easily identified through a national screening programme or even through simple diagnostic tests. However, asymptomatic cancers are on average diagnosed at a less advanced stage (Rowlingson *et al.*, 2013), although there is debate about whether this is always in the patient's best interest. For example, in breast cancer certain forms are slow to develop and therefore it may be that a patient would never be affected by the cancer in their lifetime but having it diagnosed through screening may result in them going through biopsies, surgery, chemotherapy etc. which cause discomfort and distress. There is also the problem of false positives particularly in breast cancer where in a systematic review Hofvind *et al.* (2012) identified a false positive rate between 8-21%. False positives can cause high levels of stress and anxiety for patients and the clarity of information given to patients who participate in screening has been questioned (Gøtzsche *et al.*, 2009) with regard to the risk of false positive results. In addition to this there have been concerns expressed about the diagnostic tests used and the cost. In the case of breast cancer mammograms, research has suggested that they are no more effective than a health care professional who has received training conducting a breast examination (Barton *et al.*, 1999).

In the case of the symptomatic pathway there is an issue of time, as nothing can be done until a patient presents symptoms; the GP must make a suitable referral and then the specialist needs to make a diagnosis. At any of these points delays can occur such as where a patient has delayed and then presents with a more advanced stage cancer which will have a negative impact upon their health outcome. Delay by GPs has a likewise negative

impact upon a patient's outcome. With over 200 types of cancer, for the majority there is no screening programme and these will be diagnosed through a symptomatic pathway thus putting a strain on GPs and health care resources. This makes the speed and accuracy with which a diagnosis is made, all the more important. Research has suggested, particularly in the case of ovarian cancer, that countries with a tradition of primary care, i.e. having GPs so specialist care is only accessible through primary care referral, have the worst mortality rates, therefore it has been suggested that the 'gatekeeper' process could be a factor in delay to diagnosis (Barrett *et al.*, 2010).

It should be noted that patients can fail to be diagnosed on either pathway and cases of cancer are sometimes not discovered until after death, during a post-mortem autopsy.

2. 3. EUROCARE

Information and data regarding cancer is recorded and collated in the UK by regional cancer registries. The data comes from multiple sources, such as death records, NHS records etc. Cancer registries work with a range of organisations within their area; Primary Care Trusts (PCTs), Strategic Health Authorities (SHAs), cancer networks and national organisations, such as the Office of National Statistics (ONS), to produce healthcare figures and publications.

Cancer registries are established across Europe and worldwide in selected countries. Information and data from the registries in Europe has been brought in and analysed together (with individual countries compared), in EUROCARE (European Cancer Registry); an on-going research project which has collected data and researched the survival of European cancer patients since 1989. Since the project began EUROCARE has, in addition, used the data to detect substantial changes across regions and countries over time.

2. 3. 1. Cancer survival rates

The findings of EUROCARE research have impacted and influenced UK policy and practice, particularly in recent years as the UK has been found to have one of the lowest cancer survival rates in Europe, compared with countries of similar status (Coleman *et al.*, 2008, Verdecchia *et al.*, 2007a, Allemani *et al.*, 2010, Brenner *et al.*, 2012, Møller *et al.*, 2009, Sant *et al.*, 2009). Improvements in cancer survival rates are a crucial measure as improvements in survival relate to and cause improvements in other aspects, such as quality of life. For example, in breast cancer each subsequent year of survival has been found to increase patient quality of life (Cimprich *et al.*, 2002). However it should be noted that since the start of the EUROCARE studies cancer survival for most cancers has increased and the differences between countries has decreased (Richards, 2007).

From the EUROCARE studies it was also found that in the four most common cancers (breast, colorectal, lung and prostate) and ovarian cancer, the UK had lower survival rates, compared to other European countries which had a similar national expenditure on health (Richards, 2007).

The use of survival rates as an outcome measure for cancer is common within research (Rachet *et al.*, 2010, Bonner *et al.*, 2010, Saunders and Abel, 2014, Hwang *et al.*, 2009, Abdel-Rahman *et al.*, 2009), and research into cancer survival rates outside of the EUROCARE studies have found similar results (Holmberg *et al.*, 2010, Bonner *et al.*, 2010, Morris *et al.*, 2011). Specifically, in both lung (Holmberg *et al.*, 2010) and colorectal (Morris *et al.*, 2011) cancer, when compared with countries with a similar healthcare system, such as Norway and Sweden, England had lower five-year survival rates.

There have been criticisms of this particular EUROCARE finding, regarding the study's methodology; in particular they have been criticised for underestimating UK cancer survival

rates (Wilkinson, 2009). In comparison to the majority of cancer registries across Europe the UK does not have a system of compulsory registration of cancer cases, meaning that there is a high amount of missing or incomplete data. This has resulted in England having a high rate of registry data which is excluded by the EUROCARE studies, compared with the remainder of European cancer registries. In particular England has over double the rate of cancers registered solely on the basis of death certificates (6.1% in England compared with 2.7% for Europe)(Coleman *et al.*, 2008). These are obviously excluded because the cancer has been identified after death and so there is no diagnosis date and resulting 'survival' period. While this does identify an issue in the data used by the EUROCARE studies it also highlights issues within the UK. Even though these are small percentages it still means that 6.1% of cancer cases recorded by UK cancer registries went undiagnosed during the lifetime of a patient.

Research has also identified other potential problems, some of which may account for or be associated with low survival rates. Cancer registries do not routinely collect data regarding comorbidities in patients and therefore the EUROCARE studies do not sufficiently account for the impact that other and complex health issues may have upon delay to diagnosis and/or the receipt of treatment (Quaglia *et al.*, 2009, Richards, 2009).

Since EUROCARE began, as previously stated, survival rates have improved but equally improvements in treatment, such as new chemotherapy drugs and surgical techniques and diagnostic method, such as population screening programmes, have been made. Thomson & Forman (2009) highlight that in oesophageal and pancreatic cancers improvements in chemotherapeutic regimens are responsible for improved survival rates rather than the identification of earlier stage cancers. Brenner *et al.* (2012) suggested that progress in treatment therapy is the most important explanation for survival increases in colorectal cancer, but supports that awareness and early diagnosis contribute in some way. However,

EUROCARE is and continues to be an important project as its findings have and do prompt further investigation and analysis in areas, such as diagnostic delay.

What contributes to the low survival rates found in EUROCARE has been a major topic of debate within the UK. Further investigation and analysis of the EUROCARE findings has attributed these low survival rates to diagnostic delay, specifically patients presenting with more advanced stage cancers at diagnosis (Thomson and Forman, 2009, Richards, 2007). It has been found that the UK does have significantly longer delays in patients receiving a cancer diagnosis compared to select countries in Europe (Murchie *et al.*, 2012). Similarly more advanced stage cancers are understandably harder to treat whereas in cancers which have seen, for example, advances in treatments, improvements in diagnostic criteria and early detection/screening initiatives, survival rates have improved significantly (Evans and Møller, 2003, Karim-Kos *et al.*, 2008, Coleman *et al.*, 2003, Coleman *et al.*, 2008). Even just increasing one-year survival rates has been found to have a knock on effect, in particular survival after one year is associated with increased likelihood of survival at five years (Sant *et al.*, 2009). It has therefore become a focus and priority in the UK to improve early diagnosis and reduce diagnostic delay in an attempt to improve survival rates (Fern *et al.*, 2011). However, trying to understand what causes diagnostic delay in the first place is an issue that is not fully understood (Tate *et al.*, 2009).

2. 4. Barriers to early diagnosis

The importance of delay is echoed by Macdonald *et al.* (2006) in their systematic review of upper gastrointestinal cancer, where they found that while many studies discussed delay in primary care, few actually studied it. While a clear explanation for low survival rates and diagnostic delays has not been clearly established, research has identified a number of factors or barriers that can affect patients and cause delay on their

pathway to diagnosis. Patient inequalities have been a particular focus in research and health care and it has been found that while the aim in health provision is equality for all and many strategies have been tried and implemented to provide this, socio-economic, geographical and access to healthcare inequalities still exists (Walters *et al.*, 2011, Holmberg *et al.*, 2010, Rachet *et al.*, 2010).

In the context of health care, inequality is seen as when an individual's experience differs from what is perceived as the norm. In particular age, sex, ethnic origin, geography and socioeconomic status are present across the health care system (Delamothe, 2008, Conway *et al.*, 2007, Cuthbertson *et al.*, 2009, Downing *et al.*, 2007b). The All Party Parliamentary Group On Cancer in their 2009 report on cancer inequalities support this, highlighting in addition; disability, sexual orientation and cancer type as key inequalities that need to be tackled within health care.

Inequalities in primary care have been particularly highlighted and increases in funding and government spending in the last 15-20 years reflect the motivation and need to tackle this problem (Asthana and Gibson, 2008b). The focus has been on primary care as previous research has identified that once a diagnosis has been made and patients move from primary care into secondary care and beyond, the quality of health care becomes equitable (Vedavanam *et al.*, 2009, Downing *et al.*, 2007b, Strong *et al.*, 2006). However, there is research that suggests that there are some positive inequalities present in secondary care, for example older patients receiving cancer treatment more quickly than under 50 year old patients (Robertson *et al.*, 2004).

Geographical location has been found to present a number of influencing factors and barriers. The socio-economic status of a region varies across the country, for example an inner-city area such as Central Manchester has a higher level of deprivation than North Dorset, which is more affluent (Asthana and Gibson, 2008a). Living in a more deprived area

is associated with being diagnosed with a later stage of cancer compared to patients who live in more affluent areas (Downing *et al.*, 2007b).

Areas of the UK have higher numbers of hospital admissions and death rates where there are fewer GPs per head of population (Jarman *et al.*, 2010). The suggested explanation for this is that due to the greater demand on the GPs that are available, people go untreated, due to limited consultation slots etc., and therefore end up entering the health care system at a later stage as hospital emergency admissions. Practices with more nurses perform better by QOF standards and this leads to actual improvements in patient health, rather than simply more effective administration (Griffiths *et al.*, 2010). It is generally the case that areas where there is a high demand on GPs are often areas of deprivation and within these, patients have reported experiencing delays in accessing their GPs (Mercer and Watt, 2007).

This links to what is known as the 'inverse care law', which states that those most in need of health care are those least likely to receive it. This has an impact at a population level because as demands on GPs increase, the quality of care decreases; for example reduced access to health care, shorter consultation times, which ultimately leads to increased hospital/emergency admissions. Campbell *et al.* (2001) support this finding. In their investigation for quality of care they found deprivation of an area to be a predictor of quality of care. They also found, adequate time for consultation, the size of practice and the team climate within the practice to be predictors of quality of care. In a review of oral cancer cases from the Scottish cancer registry it was revealed that increases in the number of cases diagnosed were almost entirely attributed to patients living in the most deprived areas of Scotland (Conway *et al.*, 2007). However, Ashworth *et al.* (2007) found while there were differences between practices based on location the overall differences between primary care indicators in deprived and affluent areas were small. Interestingly they did

observe that practices engaged in training performed better in deprived areas than their non-training counterparts.

The distribution of funding within Primary Care Trusts (PCTs) has been found to differ between geographical regions, for example, in Oxfordshire PCT only £5,182 is spent on cancer treatment per patient whereas in Nottingham PCT £17,028 is made available for treatment per patient (Delamothe, 2008).

Differences between cancer diagnoses in patients residing in rural versus urban areas have been well documented. Those living in rural areas have greater distances to travel to access GPS and health care facilities which contribute to presenting with advanced cancer stage at diagnosis and suffering worse outcomes, and this has been observed both in the UK (Campbell *et al.*, 2001, Lovett *et al.*, 2002, Jones *et al.*, 2008) and internationally (Liff *et al.*, 1991, Launoy *et al.*, 1992). However, there is research to the contrary. A Scottish study (Robertson *et al.*, 2004) found that in the case of breast cancer women who lived in rural areas, and therefore lived further away from health care facilities, were treated more quickly than women living closer.

Delays such as shorter consultation times can have a psychological impact upon patients in additional to delayed diagnosis. Patients who are given longer consultations by their GPs have been found to become more enabled and are therefore generally happier and more able to cope with problems (Howie *et al.*, 1999).

The type of health care centre itself could also contribute towards diagnostic and treatment delays. Cancer centres were found to have longer delays than other 'non-specialist' health care centres (Robertson *et al.*, 2004), possibly due to demand. However, patients admitted to a 'non-cancer' centre were almost 50% less likely to go on to receive

chemotherapy compared with patients admitted to cancer units or centres (Pitchforth *et al.*, 2002).

2. 4. 1. Andersen's model of delay

With such a wide ranging number of factors and barriers, attempts to organise and group these together into a model have been made. The most common of which is Andersen's model of delay (Andersen *et al.*, 1995). With this model there are three key stages that are pertinent to this research:

1. Patient – an individual recognises a symptom(s) but does not act upon it and therefore does not immediately present the symptom(s) to their GP. Similarly patients may exclude or play down symptoms when they do see a GP. A patient's ability to communicate symptoms to a GP can also be an issue that causes delay.
2. Practitioner – the GP fails to recognise the severity of the symptom(s) or does not recognise them as cancer symptoms; misdiagnosis. As a result a referral is either not made or isn't made with the necessary urgency.
3. Hospital/system – once a GP has made the referral an administration error or simply overburdened resources cause delay; for example, long waiting lists, lost paperwork, miscommunication, issues with equipment and diagnostic sensitivity.

Patient Delay

Tromp *et al.* (2005) referred to patient delay as; 'the way in which people cope with a symptom' and the way in which an individual responds to this is vital to their decision to seek medical advice, or not to as the case may be. In their research into Dutch patients

with head and neck cancer they found that an individual's coping style (whether they had an avoidant or active strategy), defensive functioning, optimism and health hardiness were most related to patient delay. A systematic review of upper gastrointestinal cancer (Macdonald *et al.*, 2006) suggested that patient delay was greater than delays attributed to GPs, with symptom recognition, patient history and patient characteristics some of the main factors associated with delay.

In the UK previous research has found that females, in particular those who are smokers or those who are in employment, delay seeking treatment for longer compared to non-smoking or retired females (Hansen *et al.*, 2009). Andersen *et al.* (1995) found that the main component of patient delay was how they interpreted their symptoms. This is more recently supported by Corner *et al.* (2006) who in their investigation of patient delay in lung cancer found that, regardless of socio-economic status, patients simply did not identify their symptoms as anything serious and therefore did not seek treatment early. Following on from this, improving education about health and cancer symptoms has been found to contribute towards reducing patient delay. From community intervention studies, such as Lyon *et al.* (2009) initiatives have been launched to raise awareness of cancer symptoms and after a year there were significantly more two week referrals and an increase in the number of diagnoses being made.

GP delay

In the same way that patients can have preconceptions that can cause delays so can GPs. Research into GPs' diagnoses of coronary heart disease found that when GPs were presented with the same symptoms by different people, females were asked fewer questions and given fewer examinations and diagnostic tests compared with males (Arber *et al.*, 2006). In addition Hansen *et al.* (2008) found that well-educated males and females

and those with a large household income experienced shorter doctor delays compared with their counterparts. Crawford (2009) observed that there was a mind set in general practice of conserving resources (which includes diagnostic tools). This causes delays and inequalities as it is then primarily the articulate and more assertive patients who get preferential care and make the most of available resources.

System delay

System delays can be difficult to measure. The most researched delay is that around date of diagnosis within the UK as there is inconsistency in cancer records as to at what point a diagnosis is officially made. For example, is it when the multi-disciplinary team at the hospital meet to make the diagnosis; is it the date the GP practice receives the diagnosis or the appointment date in which the GP informs the patient (Tate *et al.*, 2009)? System delays can also be hard to quantify as GPs may act quickly with referrals and patients be sent an appointment within the two week period. However, if a patient does not attend the appointment and is then subsequently diagnosed with cancer, the non-attendance is not always accounted for in audit and delay statistics. In Canada delays in breast cancer diagnosis were primarily attributed to system delays, specifically the scheduling of diagnostic procedures (Bairati *et al.*, 2007). Similar types of system delays have been reported in the US in the move from primary to secondary care, from receiving a diagnosis to getting treatment (Katz *et al.*, 1993)., In particular African-American females experienced the most delays, compared with other ethnic groups (Gorin *et al.*, 2007).

The importance of specifically looking at delay and its causes is echoed by Macdonald *et al.* (2006). In a systematic review of delay to diagnosis in upper gastrointestinal cancer it was found that the patient phase of delay was greatest and, where practitioner delay occurred, misdiagnosis and the presence/confounding effect of an existing health problem were the main causes of delay (Macdonald *et al.*, 2006).

The healthcare system within the UK is in some ways unique, and can therefore create a problem in terms of comparable research from other countries. However, delay and particular factors of delay do appear to be universal, with research in other countries and health systems having identified similar determinants and factors associated with delayed cancer diagnosis (Bairati *et al.*, 2007).

To tackle the issue of delays, reallocation of funding and the development of schemes and initiatives has been the usual response. Funding schemes such as the Allocation of Resources to English Areas (AREA) are delivering more money and resources into deprived areas. Macdonald *et al.* (2006), in their systematic review of upper gastrointestinal cancer found that in the last twenty years delay intervals have not actually decreased but have remained static. This suggests that despite efforts no real improvements in tackling inequalities have been made. Research by Asthana & Gibson (2008b) suggests that in terms of cancer such schemes as increasing funding in deprived areas are misguided. In their re-analysis of data from health databases (including QOF) they found that cancer was more of a burden for GPs in less deprived areas. This goes against conventional opinion and the inverse care law, suggesting that cancer is an exception compared to other diseases, such as diabetes and cardiovascular disease. The suggestion for this change in pattern is that the elderly population is one of the highest risk groups for cancer and this particular group are more likely to reside within more affluent areas. Another suggestion could be that patients in more deprived areas delay seeking consultations etc. and as a result are more likely to be diagnosed via hospital admissions, therefore by-passing the GP and primary care process all together.

2. 5. Initiatives and Schemes

In response to research and findings, such as EUROCARE, a number of schemes and initiatives have been developed and implemented.

As discussed, in the pathways to diagnosis section, initiatives such as the two week wait and screening programmes such as those for breast cancer have been implemented in an effort to identify or 'catch' cancer at an earlier stage, or where cancer is suspected that a referral to a specialist is carried out quickly. Previous research has linked early diagnosis, and diagnosis at a less advanced stage of cancer, with survival outcomes (Virnig *et al.*, 2009, Richards, 2007, Thomson and Forman, 2009) and the negative affect that delays, organisational issues, and access to healthcare can have upon early diagnosis (Holmberg *et al.*, 2010, Daly and Collins, 2007, Jiwa *et al.*, 2004). Johnson et al (2011) identified that in endometrial cancer up to 1,600 women a year will delay up to six months, in presenting symptoms to their GP, and in their review of EUROCARE findings Abdel-Rahman et al (2009) identified that between 6,600 – 7,500 of cancer cases in England resulted in premature or avoidable deaths, highlighting the importance of continued research and improvements in this area.

In November 2008 the Department of Health (DoH) created and launched, as part of its 'Cancer Reform Strategy', NAEDI (National Awareness and Early Diagnosis Initiative). The aim of NAEDI is to make progress in improving national cancer outcomes by coordinating and providing support to initiatives and research into early diagnosis of cancer. NAEDI currently have four 'work streams' to achieve this:

1. Achieving early presentation by public and patients – specifically increasing public awareness of cancer symptoms and also reducing barriers to patient access of health care services.
2. Optimising clinical practice and systems – the focus of this is around GPs and their awareness of 'red flag' symptoms along with improving referral and interaction between primary and secondary care.
3. Improving GP access to diagnostics – this has involved a survey of GPs to ascertain which resources, services and support they require to deliver a fast and accurate diagnosis.
4. Research, evaluation and monitoring – this final stream is to ensure that work done by NAEDI is accurate and to evaluate any initiatives that are developed.

Of particular interest, in the initial work conducted by NAEDI there has been a systematic review of the potential link between more advanced stages of cancer at diagnosis and poorer health outcomes in the UK. The review did find that such a link exists, supporting the idea that earlier diagnosis at a less advanced stage will give better outcomes, such as increased survival (Richards, 2009).

2. 6. Current climate

Since the start of this project there have been a number of economic and political changes that have or will affect health care and the NHS in the future. In particular the global recession that first hit in 2008, and again in 2011, has had a profound effect on the funding and resources available to the NHS.

However, everyone is feeling the effects of the global recession. Being out of work, losing a job and the threat of job losses has both a negative physical and psychological

impact on people (Torjesen, 2010). As a result, greater demands have been placed on the NHS to help and provide support; for example, within mental health in 2009, 39.1m prescriptions were issued for anti-depressants, almost double the number ten years previously in 1999 (20.1m (Davis, 2010)) and a 3.2m increase on the previous year 2008, 35.9m (Torjesen, 2010). Issues such as patients struggling to afford prescriptions for chronic conditions have risen as a result of the recession (Asthma UK, 2009).

Money into cancer research had been consistently increasing and in the last ten years has doubled, in 2010 it was £504 million and as part of the government's 2010 spending review, the fund for cancer drugs was to be increased to £200 million per year. From these figures we can see that there has been a huge amount of investment into tackling cancer but since 2010 the NHS has been set the target of reducing its spending by up to £20 billion by 2014.

It's been highlighted that within England certain regions and areas have been affected more by the recession, specifically the northern regions of the country (Whitehead and Doran, 2011). Northern regions have seen increased unemployment rates and higher government spending cuts, particularly in welfare benefits and public services (Cox and Schmuecker, 2010). Prior to the recession it had been observed that there was an unequal distribution of GPs across the country, with fewer GPs per head of population in the Northern regions. This puts Northern region NHS services in a position of having fewer resources but with a greater demand and need for those resources compared to other regions in the country.

The NHS and health care within the UK is constantly changing; regular reforms along with changes of government mean that many schemes and initiatives are put in place and then changed a few years later. In 1999, as part of a reform to implement national clinical governance the CGST (Clinical Governance Support Team) was established. The CGST was

closed in 2008 and power was transferred to a local level with individual SHAs (Strategic Health Authorities) responsible for providing clinical governance in their area. As part of the new health and social care bill SHAs will now be disbanded in favour of clinical commisioning groups.

During the time of this research there was also a change in government in 2010, from a Labour government to a coalition Conservative/Liberal Democrat government. Aside from large funding cuts in reaction to the continuing recession, the new government has looked to carry out a number of health and NHS reforms. This has resulted in a number of initiatives and schemes that are currently being implemented across the country.

2. 6. 1. GP commissioning

As part of the current government's reform of the NHS it has been proposed that from 2013 GP-led clinical commissioning groups will be established (Mannion, 2011, Charlton, 2013). GP commissioning will give GPs greater control and responsibility of their funding, which is worth £60 billion across England. It is the rationale of this reform that because patients generally access health services through their GP, GPs are best placed within health care and have the greatest knowledge of where funding and resources would be best used. This reform has received a mixed response with concerns expressed about; whether GPs will have and receive the necessary support they will require, if commissioning will take up too much of GPs' time rather than time spent with patients (which is already in high demand) and questions about how it will be fairly governed (Smith and Mays, 2012).

2. 6. 2. New NHS 'Health and Social Care Bill'

The 'Health and Social Care Bill' is a complex new Bill by the coalition government which will constitute one of the biggest NHS reforms in the NHS history. Some major changes will be the abolishment of PCTs and SHAs and the forming of a range of new bodies and regulatory groups.

Key concerns have been expressed around such a radical restructuring, particularly in the current economic climate where NHS resources and time are at their most stretched. The introduction of a greater level of competition and privatisation is also of concern as it goes against the philosophical foundations of the NHS, specifically the provision of universal comprehensive health services (Ham, 2012).

2. 7. Quality of care

As mentioned, large scale studies such as EUROCARE have sparked further and more in-depth research. From this it has been suggested and found that the quality of care a patient receives can contribute and impact upon their survival outcomes. Sant *et al.* (2009) stated that;

'. . . survival differences are greatly influenced by mortality in the first year, which in turn depends largely on tumour stage at presentation and presence of comorbidities, and these factors are again partly dependent on the quality of health care.'

The quality of care patients receive at every point from presentation through treatment has been linked and found to contribute towards survival (Sant *et al.*, 2009, Gatta *et al.*, 2010). However, the issue of what constitutes quality of care and how it is measured raises questions. In particular when looking at elderly populations it has been found that as age increases patients are treated less often; specifically, they are less likely

to undergo surgical interventions and chemotherapy (Gatta *et al.*, 2010). This could be and is interpreted as being a negative outcome, as not receiving these treatments reduces survival. However, if a patient has additional health issues/comorbidities which makes receiving such interventions risky or potentially give little benefit to the patient then withholding such treatments can be a good quality decision.

It became clear that quality of care is an important component and issue within primary care and therefore a more in-depth look at quality of care and how it is measured within primary care was conducted in the form of a systematic review, which can be found in chapter 3.

2. 8. Health database research

The funding for this research is part of an e-health initiative by the ESRC. The aim is to utilise existing health databases and, where possible to combine them for the purposes of research.

As mentioned there are criticisms of health databases regarding accuracy but equally these databases are a large scale resource that can be of great benefit to research. Despite criticisms, cancer registry data is used internationally in research to great effect, such as EUROCARE, and within England, regional and national data from cancer registries is regularly used within research.

Common problems are that data can be missing or there is inadequate information and also where there is confusion over when events have occurred, for example the use of cancer diagnosis dates. Majeed *et al.* (2007) supports this notion that databases are problematic but suggests that by linking databases together information can be cross checked, thereby improving the accuracy of the data available. This is highlighted in a study by Pascoe *et al.* (2008) where cases of cancer reported in GP records were compared

with the cancer registry. Whilst they found that one in five patients with cancer were not identified using database codes in GP records, they were able to identify the other cases via the cancer registry database.

For this research the cancer stage at diagnosis is being used as the key patient variable. Downing *et al.* (2007b) when investigating stage of cancer at diagnosis in the UK, found that from the electronic databases used, staging information was available in over 90% of cases. This is reflected in the data available from the Northern and Yorkshire Cancer Registry who list breast and colorectal as two of the commonest cancers for staging information within their dataset.

2. 9. Cancer stage as a measure

The use of stage of cancer at diagnosis is a novel approach, previously such information has been limited and inconsistent as it had simply not been recorded into health care databases or the guidelines for attributing a stage have been too ambiguous. Recent reforms to the guidelines in the staging classification of cancers such as breast and colorectal, the cancers being used in this research, have meant that the quality and validity of staging information has improved (Perry and Thurston, 2008, Fox and Fletcher, 2007). In recent years there have also been great improvements in the identification of alarm symptoms that are associated with increased likelihood of cancer which can be used to help GPs provide quicker referrals and ultimately diagnosis (Hamilton *et al.*, 2005, Jones *et al.*, 2007).

The alternative would be to use time to diagnosis but this is problematic as there is often confusion and inconsistency in health records as to what is regarded as the actual date of diagnosis. For example, some consider it to be the date the multi-disciplinary team

meet, the date the letter is sent from the GP practice or even the date of the patient's appointment with a specialist.

Stage of cancer at diagnosis and inequalities have already been linked in previous research, for example as patient distance from a cancer centre increases so does the likelihood of a high stage of cancer at diagnosis (Campbell *et al.*, 2001). In both the US and UK inequalities based on ethnicity have also been found; Hahn *et al.* (2007) observed that African-American females were more likely to be diagnosed with a later stage of breast cancer, compared with white females. In the UK Jack *et al.* (2009) had similar findings, with white females firstly more likely to actually have a cancer stage recorded at diagnosis and when compared with other ethnic groups this was more likely to be a less advanced stage.

2. 10. Research aims

The aim of this research is to utilise these new and improved sources of data to investigate the association between GP practice quality and cancer stage at diagnosis. As part of this, the effect of previously identified inequalities, such as deprivation and age, will be included to examine how they interact and affect this association.

By exploring this potential link between practice quality and cancer stage, recommendations can be made that can inform future policy, specifically informing the direction and distribution of resources and funding within primary cancer care. The working hypothesis for this research is that patients of GP practices that report higher levels of quality will show less advanced cancer stage at diagnosis compared with those from GP practices which report lower levels of practice quality. This is based upon the assumption that practices which report high practice quality are able to more efficiently diagnose potential cancer cases at an earlier stage. Equally it is hypothesised that practices which are located in deprived areas will have more advanced stage cancers.

This is an important association to investigate as much previous research has suggested that an association exists, and highlighted that GPs have an influence upon cancer diagnosis, but as yet a direct investigation has not been made. In essence we have assumed that GP quality influences cancer diagnosis without actually researching that link. Greater information and data is now held on GPs, patients and quality practices and standards and it is also the aim of this research to utilise that available data to attempt to provide more specific explanations for any links or associations found.

3. Chapter 3: Systematic Literature Review

This chapter consists of a systematic review of the methods which have been used to assess GP practice quality in cancer and its impact on patient outcomes. Quality of care is a widely debated issue within healthcare and a summary of the key points are outlined at the start of this review. Measures that have previously or are now currently used to assess quality, specifically in primary care in England, are also outlined.

A search strategy and inclusion/exclusion criteria were developed and the health databases MEDLINE and EMBASE were used for the search. A second reviewer was used to reduce bias and to assist in selecting articles which met the criteria. After the review process, 37 studies remained and a narrative analysis of these studies was conducted, with the findings reported in this review.

Review title:
Measurements and assessments of GP practice quality in cancer; from presentation of symptoms to diagnosis, and its impact on cancer outcomes

Cancer is an increasing disease burden, not just within the UK but on an international and global scale. Cancer is a worldwide leading cause of death and it is predicted that the number of deaths due to cancer will nearly double by 2030, to over 13.1m (World Health Organisation). In the UK over 300,000 cases of cancer were diagnosed in 2012, a figure which has doubled in the last five years (Cancer Research UK).

Compared with European countries of a similar status the UK has been found to have lower survival rates for cancer and diagnostic delay has been found to be a key contributor to these low survival rates (Richards, 2007, Verdecchia *et al.*, 2007a). In particular the UK has significantly longer delays in patients receiving a cancer diagnosis (Murchie *et al.*, 2012) and a greater number of patients presenting with more advanced stage cancers at diagnosis (Thomson and Forman, 2009), compared to other European countries. Further investigation into the area of diagnostic delays has highlighted the importance of quality of care in reducing delays and improving survival outcomes (Sant *et al.*, 2009, Gatta *et al.*, 2010).

This systematic review was conducted to examine the methods which had been used to assess primary care quality, with particular reference to cancer. This was in part to review what primary care quality measures and resources had been used, to inform this study if necessary, but also to see what the current knowledge base of this research area was and where the gaps lay.

Quality of care is an important issue within health care and within the UK there is some evidence that once a diagnosis has been made and a patient moves into secondary care for treatment of cancer that the quality of their care becomes equitable (Una *et al.*, 2000, Vedavanam *et al.*, 2009). However, there is good evidence that the quality of care results in delays to diagnosis for patients, and that this is mediated by factors such as, socio-economic status, ethnic background and sex (Abel *et al.*, Herold *et al.*, 1997, Johnson *et al.*, 2008, Baird and Wright, 2006, McLean *et al.*, 2006, Strong *et al.*, 2006, Adams *et al.*, 2004a, Adams *et al.*, 2004b)

What constitutes quality of care is an area of debate and the ideas and definitions in this area are continually changing and updating (Blumenthal, 1996a, Blumenthal, 1996b, Blumenthal, 2012, Roland *et al.*, 2012). There are three key issues that contribute to the difficulty in defining quality of care:

- Perspective - The role or position an individual or group has within the health care system affects and alters what is expected in terms of quality. For example, a GP may judge good quality to be that which has a good evidence base and best chance of success, while a patient may view good quality of care as the option that causes the least disruption to their normal life. It could also be that just between individuals within a group there is a difference in opinion as to what constitutes good quality of care.

- Sustainability – Particularly within the UK, the health care system experiences regular reforms, these changes can cause disruption and there is often an adjustment period following changes which can affect the provision of quality of care. Additionally, in this recession the health care system in the UK has been subject to heavy funding cuts and financial restrictions, which has led to more changes and reforms, or the cancelling of services.

- Generalisability – While the focus of this systematic review and project is on cancer, there are many other diseases, health problems and issues, which the health care system must address and treat. While it could be argued that the main points of quality of care are the same regardless of the health issue there are individual points that are specific to certain diseases and groups of health issues. In essence, what constitutes quality of care for one disease won't necessarily be the case for another disease.

Howie *et al.* (1994, 1997, 2004, 1989, 1991, 1999), investigated and conducted a number of studies and reviews during the 1990s into quality of care, particularly at a primary care level. When defining quality of care, in 1994, they stated that;

'Effective primary care entails listing the needs of a patient at a consultation, deciding on the priority for dealing with these needs, and giving care that meets the need or needs selected for attention.'

This is a particularly patient centred definition of quality of care, in later work they added that a patient's health should be improved or at least deterioration of a disease halted, unless deterioration is inevitable and then appropriate support and care should be offered. Additionally, upon leaving a consultation patients should be satisfied and their understanding and ability to cope should have increased.

Campbell *et al.* (2000, 2002a, 2003), during their research into quality of care in the early 2000s, suggested that there are two key dimensions to quality of care; access and effectiveness. Their approach could be considered more from an organisational and system's perspective, focusing on the provision of health care and its effectiveness in treating or slowing the deterioration of a disease.

The NHS in its definition of quality of care reflects and tries to incorporate these different definitions and perspectives. As the principal provider of health care within the UK it has worked to a shared definition of quality which comprises of three key elements (Darzi, 2008, National Quality Board, 2011):

- The effectiveness of the treatment and care provided to patients.
- The safety of treatment and care provided to patients.
- The experience patients have of the treatment and care they receive.

Quality standards within the UK are overseen by national and government agencies, the primary one of these is NICE (National Institute for Health and Care Excellence), which was a government agency but is now a public body. Their role is to improve health outcomes for the UK public by providing evidence-based guidance and advice and developing quality standards for health and social care. In their definition and guidance for what describes and constitutes high quality care for a patient there are fourteen points, ranging from effective communication between the patient and health professionals to respecting patient wishes and preferences and regular checks throughout their treatment (National Institute for Health and Clinical Excellence, 2012).

3. 1. How is quality of care measured?

'The effectiveness of clinical care depends on the effective application of knowledge based care'(Campbell et al., 2002b)

Measures of knowledge are a long established method for assuring and measuring quality and internationally, GP reaccreditation and training is a key and common method used (Davis and Ringsted, 2006, Lal *et al.*, 2004, Regnier *et al.*, 2005). In the US specific cancer quality assessment tools have also been developed, such as the Quality Oncology Practice Initiative (QOPI) (Neuss *et al.*, 2005).

In the UK, traditionally responsibility for quality of care has been in the hands of the individual GP and professional bodies, such as the Royal College of General Practitioners (RCGP). Continued professional development (CPD), training schemes and the associated reaccreditation checks have played a part in quality assurance but have been criticised for being imprecise measures (Scrivens, 1995).

In the later part of the 1990s, despite disagreements about definitions, quality improvement in the provision of health care became a high priority on the agenda in the UK and internationally (Campbell *et al.*, 2000). What followed was a large amount of investigation and research into quality of health care, how it could be measured and the development of a national performance network within the NHS. As a result incentive schemes were introduced, where meeting certain aims or targets results in a financial reward. Importantly for GPs this equated to additional funding for their practice for resources, such as equipment, prescriptions and staff.

These incentive schemes were incorporated into the General Medical Services contract and have developed into a scheme known as the Quality and Outcomes Framework (QOF). Since its introduction in 2004, QOF has been reviewed annually and is continually changing, in 2001/12 QOF was made up of 142 indicators across four domains. These were:

- **clinical care**: the domain consists of clinical areas, i.e. coronary heart disease, heart failure, hypertension.
- **organisational**: the domain is across six organisational areas – records and information; patient communication; education and training; quality and productivity; practice management and medicines management.
- **patient experience**: the domain relates to length of consultations.
- **additional services**: the domain is across four service areas – cervical screening, child health surveillance, maternity service and contraceptive services.

QOF has received a lot of criticism since it was first introduced. Initially there were questions regarding whether it was measuring the correct indicators and whether it was in-line with the guidance of other quality agencies, such as NICE (Vedavanam *et al.*, 2009, Downing *et al.*, 2007b, Short, 2007). Particularly for the question asked in this review, where the focus is on quality of care in cancer, QOF indicators related to cancer are limited, mainly relating to prevalence and follow up care rather than diagnosis.

There have also been a number of questions raised about the option for GPs to exception report within QOF. This is where GPs can exclude patients from the numerator for an indicator on specified grounds. A trend of high exception reporting was observed within deprived areas, with the suggestion that this trend was an attempt to maximise funding rather than legitimately excluding exceptional cases (Sigfrid *et al.*, 2006, McLean *et al.*, 2006).

Brook *et al.*(1996) stated;

'It will never be possible to produce an error-free measure of the quality of care'.

This is an important consideration, as while an error-free measure is impossible, it is therefore all the more important to ensure that the measure(s) that are being used are as appropriate and accurate as possible. Concerns have been voiced and research has found that inappropriate methodologies and inaccurate data have been used to measure quality of care and this ultimately has a negative impact upon quality but also wastes resources and can mean real issues are side-lined (Blumenthal, 1997, Blumenthal, 2012, Brook and McGlynn, 1996, Campbell *et al.*, 2002b).

3. 2. Review objectives

The aim of this review is to identify and assess recent and current assessments of GP practice quality and the potential link, influence and impact this has upon cancer diagnosis.

3. 3. Search strategy

For this review a search string of relevant key words was developed to find articles which related to cancer and the quality of primary care. The searches were conducted in EMBASE and MEDLINE. Keywords were identified through MeSH terms relating to cancer and practice quality from already identified literature and subgroups available in EMBASE and MEDLINE.

For this review the key aspects were; cancer and GP quality. While certain terms were kept general and open, such as the keywords for cancer (cancer or neoplasm), there were problems with identifying suitable keywords for practice quality. In particular when quality was used as a keyword the majority of articles that were returned related to quality of life. More specific and direct keywords were developed from the MeSH terms (i.e., health care quality or quality control in EMBASE) and primary care as a keyword was added to help reduce the number of palliative/secondary care articles.

Measuring GP practice quality is a reasonably new concept with systems such as QOF only being introduced within the last ten years. Equally healthcare practices and structures are constantly changing and therefore studies, for example, from the 1950s would not be relevant. As a result a cut off was placed, by the lead reviewer, to only include studies from 1980 to 2011. While the UK health care system is unique and articles from other countries may not be directly relevant these were still included, for comparative narrative analysis, provided they assessed practice quality and cancer.

Slightly different strategies were required for the two databases due to differing MeSH terms, for example, family physician instead of general practitioner.

It is worth noting that the need to vary MeSH terms could be down to the different make-up of the two databases. In particular the results from EMBASE were much more likely to be UK and European articles, where the term GP or general practitioner is used. In comparison when searching MEDLINE the use of GP or general practitioner was not recognised but physician or family physician was.

While both EMBASE and MEDLINE are well-known and used biomedical databases there are differences between the two. MEDLINE (Lancet Oncology, 2001) is part of the US National Library of Medicine and currently consists of over 19 million references from 5,600 different worldwide journals in the area of life science, with a concentration on biomedicine. EMBASE (Hansen *et al.*, 2008) in comparison is a biomedical database by the European based, global publishing company Elsevier, and has over 25 million references from over 7,600 different worldwide journals.

While there is a large amount of overlap between the two databases in their aims and the references they contain, there would also appear to be differences in their approach. In particular, the fact that MEDLINE is led by a US based organisation might contribute to and explain why the majority of studies in the MEDLINE search output were US based studies. This may also explain why using the term physician in the search strategy, which is more commonly used in the US, worked more efficiently in the MEDLINE search.

Between the two databases some differences in the joining of terms had to be made. Specifically the combining of terms such as GP and primary care by using 'and' or 'or'. Initially terms related to GP (GP, general practice and general practitioner) were combined together and terms related to primary care (primary health care and primary medical care)

were combined together separately. This worked well in EMBASE but in MEDLINE a large number of palliative care articles were returned. This could be due to the involvement of GPs in post diagnostic care as co-ordinators for continuous and palliative care and it is a QOF indicator that GPs are required to do a three to six month review of cases. The decision was made in MEDLINE to combine the 'GP' and 'primary care' terms to reduce the number of continuous and palliative care studies.

3. 4. What to include/exclude?

Cancer is a wide ranging disease, affecting different areas of the body, and each cancer type presents in different ways. As a result patients arrive at a diagnosis through a range of pathways and scenarios. While GPs are often thought of as the gatekeepers to secondary care there are cancer pathways which can by-pass GPs. Diagnostic pathways can be categorised as follows;

1. Symptomatic – this could be considered the more traditional pathway whereby a patient makes an appointment to see their GP, presents symptoms which could be cancer and is subsequently referred for diagnostic/specialist test(s).
2. Asymptomatic – in this case the patient has not presented any symptoms to a GP and may in fact not demonstrate any outward health problems but has been through a screening examination that has picked up potential signs of cancer and a resulting referral for diagnostic/specialist test(s) has been made. For example, in England there is a national breast screening program which targets women between the ages of 50-70 (the high risk age group for breast cancer) to have a mammogram every three years during this age range. This screening is co-ordinated via regional centres rather than through their GP; in contrast the cervical screening programme is delivered through general practice.

The decision to include international studies means it is important to bear in mind the differences in health service provision between countries. In the UK screening for selected cancers, such as breast and the use of mammograms, has also become part of private practice. Patients, at a cost, can request such screening as part of a health check or examination. The use of private health services is increasing within the UK but in other parts of the world, such as the USA, it is well established.

The distinction between symptomatic and asymptomatic patients is important because it impacts upon the level of interaction and therefore the quality of care the patient receives from their GP. While the quality of screening techniques and programmes may influence cancer outcomes GPs do not always conduct or are involved with cancer screening. Therefore, for this review measurements and assessments of screening and asymptomatic cancer pathways were not included as the involvement of a GP is not consistent.

Within England there has been an effort to measure and reward GP practice quality with the introduction of the Quality and Outcomes Framework (QOF). QOF has only been introduced in the last ten years and has already undergone a number of reforms. Similar systems are not yet established in other countries. For this review systems such as QOF are useful as they provide a clear measure of quality with clear outcomes. In the absence of such a system, GP practice quality can be measured by a wide variety of alternative methods. When trying to determine whether a method is appropriate for this review it is important to remember and focus on whether firstly GP quality is actually part of the outcome and secondly whether there is some form of quantifiable measure.

3. 5. Inclusion/exclusion criteria

To meet the objective of this review, inclusion and exclusion criteria were required to identify which studies should be included in the narrative synthesis. The criteria were as follows:

1. Cancer related – All cancers were included. Other diseases may be mentioned or be the focus but cancer must be included in the analysis in some way.
2. Measures or assesses GP quality – A form of measurement or assessment needs to be used. On a specific note, articles which look at guideline adherence would also be a measure of quality. Decisions to refer for screening can be included and used as a measure of quality.
3. Diagnosis – Studies of patient after care and management were excluded, since the focus of this review is on the period leading to diagnosis. Studies which look at delay to presentation or care after diagnosis were not included.
4. Genetic testing – Studies of genetic risk assessment were excluded.
5. Skin surgery – Studies in this area needed careful consideration. Skin lesion removal is a common procedure by GPs. GPs' performance can be measured against guidelines, e.g. for excision margins, and these studies were included. However, studies which compare GPs' performance against that of specialists, but not against objective standards or guidelines were excluded.
6. Screening - It is important to highlight that cancer screening programmes operate in different ways. For example, breast cancer screening is not done by GPs. Therefore any articles which solely addressed breast cancer screening were excluded. However, other cancer screening, such as cervical, is done in practice and is a measure of practice quality. As a result articles which related to screening

were carefully considered and only included if they were directly related to GPs and/or practice and the quality/provision of services.

7. Additional –
    a. Reports had to be of primary studies, therefore reviews, editorials etc. were excluded. Articles should be in English, articles in other languages were excluded and articles had to have been published in or after 1980.
    b. Influences on GPs - measures such as GP preferences and patient influence on GP, i.e. sex of GP, patient demands or GP behaviours like smoking are not direct measures of quality. However these articles were included as they look at influential factors which ultimately impact upon quality and generally these articles to discuss the impact upon a quality measure, e.g. a study into why GPs overuse PSA testing.

3. 6. Review process

Once the search strategy and review criteria had been developed, the principal investigator (HW) then conducted the review. First, by carrying out the search strategy in both EMBASE and MEDLINE and then reviewing the two sets of search results, excluding any studies which did not fulfil the review criteria. A number of studies could be excluded by reviewing the titles; for example, if there was mention of continuous or palliative care within the title, but the majority required a review of the studies abstracts to make the decision as to whether it met the review criteria. Once both search results had been reviewed the process was then repeated by a second reviewer.

To help reduce any investigator bias a second reviewer (Lynne Forrest) reviewed the search outputs. Once the search strategies have been developed and carried out, a copy of the outputs and the above inclusion/exclusion criteria was given to LF. LF then

independently reviewed the search results, excluding articles which did not fulfil the review criteria. The next step was to review the abstracts that remained and further exclude any articles which did not meet the criteria on further scrutiny. The principal investigator (HW) and LF then met and discussed which studies they had identified as being eligible. Any study where there was not a consensus was then discussed as to decide its eligibility and whether it would be included in the final number; if an agreement could not be reached the study was given to a third reviewer (Greg Rubin) for a decision.

Once an agreed list had been compiled, then the full article was reviewed by the principal and second reviewer and any final discussions or exclusions were made. The final studies were then selected and for these, the reference sections were hand searched, by HW, for additional articles which may have been of interest/relevant to the review.

3. 7. EMBASE

The keywords and number of articles, number shown in the brackets, which were found in the EMBASE search were as follows:

1. cancer.mp. or neoplasm/ (1559275)
2. GENERAL PRACTICE/ or GENERAL PRACTITIONER/ (94851)
3. exp HEALTH CARE QUALITY/ or QUALITY CONTROL/ (1504228)
4. PRIMARY HEALTH CARE/ or PRIMARY MEDICAL CARE/ (79202)
5. 1 and 2 and 3 and 4 and 5 (309)

One article was unavailable in English and this was excluded.

3. 8. MEDLINE

The search was also conducted in MEDLINE, with slight changes to the keywords as the two databases have differing MeSH terms, i.e. family physician instead of general practitioner. Initial searches in MEDLINE brought back large numbers of articles and also a large number of palliative care and quality of life articles so the search had to be further refined and made more specific and detailed (compared to the EMBASE search) to reduce the number of these articles.

1. Cancer.mp. or Neoplasms/ (876977)
2. Health Care Surveys/ or "Delivery of Health Care"/ or "Outcome and Process Assessment (Health Care)"/ or "Quality of Health Care"/ or Quality Assurance, Health Care/ or Family Health/ or "Outcome Assessment (Health Care)"/ or Quality Indicators, Health Care/ (224644)
3. Family Practice/ or Physicians, Family/ (68792)
4. Family Practice/ or General Practice/ or Primary Health Care/ (97226)
5. 3 or 4 (106970)
6. Delayed Diagnosis/ or Early Diagnosis/ (7751)
7. "Referral and Consultation"/ (44673)
8. Healthcare Disparities/ or Health Status Disparities/ (6173)
9. 6 or 7 or 8 (58205)
10. 2 or 9 (277090)
11. 1 and 5 and 10 (845)
12. Remove duplicates from 11 (837)
13. Limit 12 to (english language and yr="1980 -Current") (759)

3. 9. Final articles

After review the final number of studies was 37. Due to the nature of the topic area and the wide variety of methods within the studies it was deemed appropriate to group together studies which had common themes, for narrative synthesis. As a result four primary categories were produced, with two of these being further sub-divided:

1. Self-reported guideline adherence – referral to screening [18]
    a. Guidelines only [11]
    b. Other influencing factors [7]
2. Organisational [4]
3. Clinical guideline adherence [12]
    a. Screening [3]
    b. Referrals [5]
    c. Excisions [4]
4. GP influences [3]

A Table (1) outlining and summarising each article follows:

Table 1. Outline summary of the papers included in the systematic review.

Self-reported guideline adherence

Guidelines only

Author/Date	Title	Location	Topic	Sample (N)	Measures and method of assessment	Summary of study
Ka'ano'i *et al.*, 2004 (Ka'ano'i *et al.*, 2004)	Primary care physicians' knowledge, attitudes and practices related to cancer screening and cancer prevention clinical trials	US - Hawaii	Cancer screening and clinical trials	N = 254	GPs surveyed	GPs responded that that they were familiar with screening guidelines, ranging between 55-90% for different types of screening. Awareness and interest in clinical trials was around two thirds.
McGregor *et al.*, 2004 (McGregor *et al.*, 2004)	Colorectal cancer screening: practices and opinions of primary care physicians	Canada	Colorectal cancer screening	N = 965	GPs surveyed	41.9% of the GPs were not familiar with the current guidelines but most (72%) thought screening was beneficial but had concerns about cost-effectiveness and access to resources.

Stokes-Lampard *et al.*, 2005 (Stokes-Lampard *et al.*, 2005)	Vaginal vault smears – 'know more – do less': a questionnaire survey of primary health care practitioners	UK - England	Papanicolaou smears	N = 424	GPs, nurses etc. postal survey	Nurses took significantly more smears than GPs. No difference in knowledge scores between nurses and GPs, however those with higher knowledge scores took less smears. To the vignette question only 11% of respondents gave the correct answer.
Yabroff *et al.*, 2009 (Yabroff *et al.*, 2009)	Specialty differences in primary care physician reports of Papanicolaou test screening practices: a national survey, 2006 to 2007	US	Papanicolaou test	N = 1,212	GP survey - questionnaire with vignettes	Surveyed using vignettes found that many primary care physicians were over testing against guidelines recommendations, for example, continuing to pap test when there is no cervix in older women.
Xilomenos *et al.*, 2006 (Xilomenos *et al.*, 2006)	Colorectal cancer screening awareness among physicians in Greece	Greece - national	Colorectal cancer screening	N = 211	Survey	50% of physicians recommended screening as part of a usual check-up. Cost of tests was found to potentially influence the recommendation to screen, with 77% of physicians recommending screening to people over 50 and this dropped to 53% when cost was taken into account. Younger physicians (aged 30 or less) were found to significantly recommend CRC screening less than older physicians.

Youl *et al.*, 2006 (Youl *et al.*, 2006)	Attitudes, knowledge and practice of CRC screening among GPs in Queensland.	Australia - Queensland	Colorectal cancer screening	N = 769	Survey	66.4% recommended screening for patients over 50 and 97.4% recommended colonoscopy for patients with a significant family history of CRC. 71.2% reported receiving at least one type of guideline for CRC screening, only 5% reported not finding the guidelines useful. Between 1999 (date of previous survey) and 2002 (date of current survey) there has been a significant increase in knowledge and recommended screening.
Smith & Herbert, 1993 (Smith and Herbert, 1993)	Preventive practice among primary care physicians in British Columbia: relation to recommendations of the Canadian Task Force on the Periodic Health Examination.	Canada – British Columbia	Cervical, breast, lung and colorectal cancer	N = 186	Survey	90% of physicians reported compiling with task force recommendations and guidelines. Lack of patient compliance was cited as a frequent reason for patients not being screened. Physician and practice characteristics were also examined but not found to have any significant impact upon physicians' decisions to screen or order tests.
Federici *et al.*, 2005 (Federici *et al.*, 2005)	Survey on colorectal cancer screening knowledge, attitudes, and practices of general practice physicians in Lazio, Italy.	Italy - Lazio	Colorectal cancer screening	N = 699	Survey	95% of respondents understood that CRC is a preventable disease but 22% do not recommend screening. A high screening knowledge score, agreement with international guidelines, and the use of scientific literature as a source of information, increased the probability that screening was correctly recommended. GP characteristics were not found to have any affect upon correct recommendation for screening. 32% recommend inappropriate follow-up tests.

Pendleton *et al.*, 2008 (Pendleton *et al.*, 2008)	Knowledge and attitudes of primary care physicians regarding prostate cancer screening.	US - Florida	Prostate cancer screening	N = 104 physicians	Survey and questionnaire	Mean knowledge score was 66%, with correct responses to questions ranging from 14 – 98%. Only 53% of physicians offered screening to minorities, compared to 70% to patients with a family history of prostate cancer. Attitude responses to prostate cancer screening guidelines ranged from 45 – 93% agreeing with the correct recommendations.
Roetzheim *et al.*, 1991 (Roetzheim *et al.*, 1991)	Compliance with screening mammography. Survey of primary care physicians.	US – Tampa Bay	Breast cancer screening	N = 565	Survey	92% of respondents reported that they were familiar with ACS guidelines, but only 62% reported being in full compliance, younger (under 50) physicians and female physicians were significantly more likely to be in full compliance with guidelines.
Klabunde *et al.*, 2003 (Klabunde *et al.*, 2003)	A national survey of primary care physicians' colorectal cancer screening recommendation and practices.	US - national	Colorectal cancer screening	N = 1,235	Survey	Despite high awareness of CRC screening guidelines, several of the CRC screening recommendations and practice which physicians reported following were inconsistent with current guidelines, for example, 50% of primary care physicians recommended screening in younger patients. Despite 98% of physicians reporting that they would recommend CRC screening to average risk patients, national figures for the ordering of tests is low.

Other influencing factors

Author/Date	Title	Location	Topic	Sample (N)	Measures and method of assessment	Summary of study
Gormley *et al.*, 2006 (Gormley *et al.*, 2006)	Prostate-specific antigen testing: uncovering primary care influences.	UK – Northern Ireland	Prostate testing PSA	N = 704	Postal survey of GPs	Prostate cancer screening is not recommended by guidelines however PSA testing is common. Awareness of guidelines among GPs was low, 49%, with more male GPs carrying out PSA tests compared with female. Patient's requests, working full-time, influence of services (urology dept.) and training meetings etc. had an influence upon GPs' behaviour.
Haas *et al.*, 2007 (Haas *et al.*, 2007)	Association of regional variation in primary care physicians' colorectal cancer screening recommendations with individual use of colorectal cancer screening.	US - national	Colorectal cancer screening, regional variation	N = 12,727	Two national health and cancer screening surveys (NHIS, NCI-SCCP)	On average 53.3% of physicians recommended initial screening within the guidelines, and 64.8% advised follow-up screening at the recommended frequency. Regional differences were found and if a physician was located in a 'low-screening' region then this percentage reduced. Hispanics were significantly less likely to have been screened and those with a lower level of education.

Santora *et al.*, 2003 (Santora *et al.*, 2003b)	Breast cancer screening beliefs by practice location.	US – New York	Breast cancer, practice location	N = 469 clinicians, 199 nurse practitioners, 202 primary care physicians, 68 physician assistants	Survey	Urban practitioners were more likely to be board-certified and involved in training. Younger physicians were more likely to answer three or more items correctly regarding screening, and female physicians were also significantly more likely to correctly answer three or more items. 65% of respondents reported using some form of written screening guideline, with urban and suburban physicians less likely to use written guidelines compared with rural area physicians.
Haggerty *et al.*, 2005 (Haggerty *et al.*, 2005)	Patients' anxiety and expectations: How they influence family physicians' decisions to order cancer screening tests.	Canada	Prostate, breast, colorectal cancer screening	N = 351	Survey with vignettes	88% of physicians reported that patients' anxiety or expressed expectations of being tested influenced their decision to order a test. Most physicians were aware and followed guidelines but whether they agreed with them was most influential on their decision to order test, followed by patient factors such as anxiety or expectation to be tested.
Gorin *et al.*, 2007 (Gorin *et al.*, 2007)	Intraurban influences on physicians' colorectal cancer screening	US – New York	Colorectal cancer screening, location variation	N = 1,685	Self-report questionnaire	Differences in the methods of screening where found, with physicians based in low-SES urban practices more likely to screen using fecal occult blood test, while physicians in upper-SES practices were significantly more likely to recommend and screen using colonoscopy. Physicians in

	practices.					upper-SES practice were significantly more likely to be a US medical school graduate, non-Hispanic white, been practising for longer, see fewer patients per week and the majority of patients are non-Hispanic white. However, there was no significance difference in the knowledge of CRC risk factors etc. between physicians.

Shieh *et al.*, 2005 (Shieh *et al.*, 2005)	The impact of physicians' health beliefs on colorectal cancer screening practices.	US – St. Louis	Colorectal cancer screening	N = 115	Self-report questionnaire	Self-reported compliance with guidelines was reported as 91.3%, with 79% of physicians agreeing with the published guidelines. For physicians who were eligible for CRC screening 82.6% personally participated, with a significant difference between those who personally participated in screening and their recommendation for screening to patients.
Sorum *et al.*, 2003 (Sorum *et al.*, 2003)	Why do primary care physicians in the United States and France order prostate-specific antigen tests for asymptomatic patients.	US – New York, France	PSA testing	N = 32 US physicians, 32 French physicians	Self-report questionnaire	A significant predictor of ordering PSA tests was if a physician had previously not tested a patient who had later been found to have advanced stage cancer. US physicians also ordered significantly more tests than French physicians, and the US physicians also reported higher scores for concerns about malpractice and feeling pressure from patients.

Organisational

Author/Date	Title	Location	Topic	Sample (N)	Measures and method of assessment	Summary of study
Downing *et al.*, 2007 (Downing *et al.*, 2007b)	Do the UK governments new quality and outcomes framework (QOF) scores adequately measure primary care performance? A cross-sectional survey of routine healthcare data	UK - England	QOF	N = 2PCTs (516,620)	QOF and hospitals admissions	QOF data was linked to hospital admissions. Higher scores in the clinical domain were associated with lower hospital admission rates, specifically with cancer. No clear association between the organisational domain and admissions. High levels of deprivation were associated with increased likelihood of admission and females overall had significantly fewer admissions for cancer than males. Any associations observed were generally not consistent but were significant in cancer. Admissions were most strongly associated with deprivation rather than QOF.
Wang *et al.*, 2006 (Wang *et al.*, 2006)	Practice size and quality attainment under the new GMS contract: a cross-sectional	UK - Scotland	QOF practice size	N = 638	QOF and practice information	Single-handed and small practices accounted for 45% of all urban practices, had greater list sizes compared with larger practices and were less likely to participate in voluntary quality schemes and training. Patients who attended these smaller and single-handed practices

	analysis.					lived in more socioeconomic deprived areas, had poorer health and premature mortality. Patients were also more likely to be of an ethnic minority. Single-handed and smaller practices scored lower overall but the only significant difference was in the organisational domain. Smaller practices also reported higher levels of cancer prevalence and conditions such as COPD and mental health.
Gavagan *et al.*, 2010 (Gavagan *et al.*, 2010)	Effect of financial incentives on improvement in medical quality indicators for primary care.	US – Harris County	Financial incentive scheme, Papanicolaou smears, mammography	N = 11 clinics	Retrospective review of administrative data, survey of clinicians	Outcomes of primary care clinics which had a financial incentive scheme and clinics which did not were compared and no significant difference was found. The survey of clinicians found that many reported they did not feel that incentives were effective in improving quality of care.
Hippisley-Cox *et al.*, 2001 (Hippisley-Cox *et al.*, 2001)	Do single handed practices offer poorer care? Cross sectional survey of processes and outcomes.	UK – Trent region	Breast and colorectal cancer referral rates	N = 300 colorectal cancer cases N = 131 breast cancer cases	Cancer stage	A borderline association was found in late presentation of colorectal cancer and a high number of referral rates, but overall no clear or substantial outcomes were found between the number of referrals made by a practice and the patient's cancer stage.

Clinical guideline adherence

Screening

Author/Date	Title	Location	Topic	Sample (N)	Measures and method of assessment	Summary of study
Parkerton *et al.*, 2003 (Parkerton *et al.*, 2003)	Effect of part-time practice on patient outcomes	US	GP hours	N = 194	Patient data and physician characteristics	GP practice information was reviewed and it was found that GPs who worked part-time had significantly higher cancer screening and patient satisfaction levels. A number of reasons why this may be are proposed including that part-time GPs are less stressed, compensate in their performance because they're only part-time, have more time outside of working hours to keep up-to-date with skills training, guidelines etc.
Hoffman *et al.*, 1998 (Hoffman *et al.*, 1998)	Prostate-specific antigen testing practices and outcomes.	US – New Mexico	Prostate-specific antigen test	N = 1,448	Retrospective cohort study from New Mexico SEER tumour registry	Testing practices varied considerably from guidelines, specifically annual testing was not conducted and a substantial proportion of testing occurred outside of the recommended age range. For example, 16% of tests were conducted on men over 75 which is not recommended by the current guidelines.

Salinas *et al.*, 1998 (Salinas *et al.*, 1998b)	Quality differences between rural and urban primary care: the case of a cervical screening programme.	Mexico – Nuevo Leon	Papanicolaou test	N = 750	Review of cervical smear reports	No technical, physical or administrative failures were found and the overall smear processing quality was found to be highly satisfactory; however, the quality of sampling was found to be unsatisfactory. 33.4% of smear test samples were found to be unsatisfactory. Overall there was no difference between rural and urban location but the quality of smear sampling differed significantly between rural and urban locations.

Referrals

Author/Date	Title	Location	Topic	Sample (N)	Measures and method of assessment	Summary of study
John *et al.*, 2007 (John *et al.*, 2007)	Inter general practice variability in use of referral guidelines for colorectal cancer.	UK	Colorectal cancer referrals	N = 175 patients N = 129 GPs	Postal survey for GPs and patient data	While many of the GPs surveyed said they were aware of guidelines, they were unable to answer questions correctly that referred to guidelines. Only a quarter of GPs had received training regarding guidelines. In practices there was a discrepancy between the use of TWR and cancer diagnosis. In 53% of practices surveyed no colorectal cases were diagnosed through the TWR system and their use of the TWR pathway was lower than practices which had diagnoses made through the TWR system who used the TWR system more.
Debnath *et al.*, 2002 (Debnath *et al.*, 2002)	Guidelines, compliance, and effectiveness: a 12 months' audit in an acute district general healthcare trust on the two week rule for suspected colorectal cancer.	UK – North East	Colorectal cancer referrals	N = 239	Information from case notes and pathology departments.	96.2% of patients received an appointment within two weeks once a referral was made, higher than national average figures for England (81.2-81.8%). There was a significant association between diagnosis and guidelines compliance. However, it was found that there was a high rate (97.5%) on incompleteness in referrals, for example, that information and details such as family history were missing.

Webb & Khanna, 2006 (Webb and Khanna, 2006)	Can we rely on a general practitioner's referral letter to a skin lesion clinic to prioritize appointments and does it make a difference to the patient's prognosis?	UK – West Midlands	Skin lesion referrals	N = 202	Review of GP referral letters.	22% of letters did not comply with guidelines. 42% of referral letters gave no indication of priority (i.e. urgent etc.). Of the 35 cases which were later found to be cancerous, only 5 complied with two week wait guidelines.
Khawaja & Allan, 2001(Khawaja and Allan, 2001)	Audit of referral practice to a fast-access breast clinic before the guaranteed two week wait.	UK - Eastbourne	Breast cancer referrals	N = 100	Fast-access/two week wait referral information for 100 consecutive patients was reviewed.	Only 80% of referrals adhered to the guidelines. 20% upon review by a specialist were deemed to be inappropriate and 30% were deemed 'non-urgent'.
Melia *et al.*, 2008 (Melia *et al.*, 2008)	Urological referral of asymptomatic men in general practice in England.	UK – Chichester, Sutton & Merton, Truro and York	Urological referrals	N = 5,348	Referral requests and pathology reports before and after new guidelines were launched.	No significant difference in referrals was observed after the introduction of new guidelines. No significant differences were found or observed between the different practice and hospital locations.

Excisions

Author/Date	Title	Location	Topic	Sample (N)	Measures and method of assessment	Summary of study
Neal *et al.*, 2008 (Neal *et al.*, 2008a)	Excision of malignant melanomas in North Wales: effect of location and surgeon on time to diagnosis and quality of excision	UK - Wales	Melanoma excision	N = 578	Patient data	16% of lesions were removed in general practice, after 1997 guidelines there was a decline. However, there were differences between the quality of excision, with excisions being done in general practice having the lowest quality margins and least adherence to guidelines on margins compared to excisions done in hospitals.
Bakhai *et al.*, 2010 (Bakhai *et al.*, 2010)	A retrospective study comparing the accuracy of prehistology diagnosis and surgical excision of malignant melanomas by general practitioners and hospital specialists.	UK – London	Melanoma excision	N = 213 reports	GP and specialist data between 1989 – 2006 - Histopathology reports and recorded excision margins.	GPs carrying out excisions on suspected melanomas do not perform as well against guidelines as hospital specialists (GP = 29.8% compliance versus 70.5%). Although since the introduction of new guidelines they have improved but are still significantly outperformed by specialists (GP = 41% compliance versus 80%).

Pockney *et al.*, 2009 (Pockney *et al.*, 2009)	Recognition of skin malignancy by general practitioners: observational study using data from a population-based randomised control trial.	UK - Southampton	Skin malignancy	N = 491	Quality of minor surgery performed by GPs and hospital doctors from records and reports collected during a randomised-control trial.	Agreement between the diagnosis by a GP and the histology was agreed to be moderate at best, with GPs failing to recognise one-third of the skin malignancies. However, it is highlighted that hospitals do not have the capacity or resources to take on these minor surgeries.
Goulding *et al.*, 2009 (Goulding *et al.*, 2009)	Dermatological surgery: a comparison of activity and outcomes in primary and secondary care.	UK - London	Skin malignancy	N = 1,111	Retrospective review of histopathology reports and specimens.	GPs were found to be less accurate in their eventual diagnosis and had higher excision margins compared with dermatologists. Plastic surgeons were most likely to perform inappropriate procedures. 13.8% of tumours which GPs operated on should have been referred to secondary care.

GP influences

Author/Date	Title	Location	Topic	Sample (N)	Measures and method of assessment	Summary of study
Carney *et al.*, 1993 (Carney *et al.*, 1993)	The periodic health examination provided to asymptomatic older women: an assessment using standardized patients.	US – New England	Cancer prevention services	N = 57	Standardized patient (actress) presenting identical symptoms to different GPs	The development of a standardised patient as a measure of GP quality and consistency. The response to identical requests for a 'check-up' (which included cancer screening) varied widely in cost, service and time spent with GP. Cancer guidelines were not met to varying degrees and prevention advice, such as cessation of smoking, while recommended, little assistance was given.
Daly & Collins, 2007 (Daly and Collins, 2007)	Barriers to early diagnosis of cancer in primary care: a needs assessment of GPs	Ireland	Cancer diagnosis	N = 929	GPs - Focus groups and postal questionnaires	GPs reported a lack of communication between themselves and hospital services, difficulties in accessing hospital services, and unclear cancer guidelines. GPs did observe a difference between the access and waiting times for private and public patients, private patients being referred quicker and receiving better access to services.
Jiwa *et al.*, 2008 (Jiwa *et al.*,	Referring patients to specialists: A	Australia - Western	Colorectal cancer	N = 260	GP survey which included vignettes	Referral decisions between the two countries were similar, but it was found that location and clinical variables influenced GPs'

2008)	structured vignette survey of Australian and British GPs	UK - England	referrals			decisions (however this was not further investigated). Australian GPs had better outcomes for colorectal cancer, despite this study's finding that referrals are similar; therefore it is proposed that problems in diagnosis and secondary care could be to 'blame' for poorer outcomes.

3. 9. 1. Self-reported guideline adherence – referral to screening

This group of studies all have the primary outcome measure of GPs' adherence to guidelines in relation to screening, specifically whether they are following guidelines when recommending screening to patients or demonstrate accurate knowledge of current guidelines. The methodology used in all the studies is self-report surveys of GPs. A variety of questionnaires have been developed and used, some with questions about the GPs' recommendations, direct questions about guidelines and patient vignettes to assess knowledge and behaviour.

The immediate problem with the quality of these studies is that they are self-reporting, specifically GPs may respond more positively about their attitude and adherence to screening guidelines.

3. 9. 1. 1. Guidelines only

This sub-group of 11 studies all have the primary aim and objective to measure screening behaviour. Only one study is from the UK with the others coming from the US [5], Canada [2], Europe [2] and Australia [1]. The majority focus upon colorectal cancer screening but cervical smear, vaginal vault smears, breast and prostate screening are also covered.

Yabroff *et al.* (2009) found that 84.3% of GPs responding to their questionnaire believed that screening guidelines were influential on their behaviour. When presented with patient vignettes however, on average less than 25% of responses were consistent with current guidelines. This finding is repeated in nearly all the studies with a high proportion of GPs reporting being familiar or having good knowledge of the guidelines but then in practice, compliance or correct responses to vignettes is low (Roetzheim *et al.*, 1991, Ka'ano'i *et al.*, 2004, Klabunde *et al.*, 2003, Smith and Herbert, 1993, Stokes-Lampard

et al., 2005, Xilomenos *et al.*, 2006). One study compared their results against (Youl *et al.*, 2006) a previous survey and found that knowledge and compliance, while still not 100%, had improved significantly in a five year period.

Federici *et al.* (2005) found a strong association between GPs who demonstrated good knowledge of guidelines and compliance with guidelines, however Pendleton *et al.* (2008) failed to confirm this. In a survey of Greek GPs (Xilomenos *et al.*, 2006), where there are no national guidelines and overall knowledge of colorectal screening is poor, half the GPs recommended colorectal cancer screening as part of a routine check-up for high risk groups. European guidelines were cited as the ones most commonly followed (Xilomenos *et al.*, 2006).

Seven studies recorded GP demographic information and investigated its relationship to GPs' beliefs and attitudes to screening. Significant differences were found between GPs' compliance with guidelines and age, with GPs over 50 being less compliant (Roetzheim *et al.*, 1991, McGregor *et al.*, 2004). Pendleton *et al.* (2008) found older and urban based GPs had higher attitude scores towards screening, i.e. were more likely to offer screening annually, to minorities and over 50s. Differences in the GPs' specialisms were also observed to affect behaviour, specifically GPs who specialised in obstetrics and gynaecology were significantly more likely to order pap screening (Yabroff *et al.*, 2009). However, a similar number of studies found no association between GP demographics and specialism with screening attitudes and beliefs (Smith and Herbert, 1993, Stokes-Lampard *et al.*, 2005, Xilomenos *et al.*, 2006).

The quality of these studies is generally poor. Knowing whether or not GPs are adhering to guidelines can be considered a valid measure of quality but when the information is self-reported, its veracity is questionable. The number of respondents in each study varied widely (n = 104(Pendleton *et al.*, 2008) – 1235(Klabunde *et al.*, 2003)) as

did the response rates (range = 39.39 (Pendleton *et al.*, 2008) – 80% (Stokes-Lampard *et al.*, 2005)). Studies reporting associations between GP demographics and behaviour do add an extra dimension, demonstrating that GP factors such as age and sex may have an influence upon behaviour and practice.

3. 9. 1. 2. Other influencing factors

Seven studies examined screening guidelines adherence through the use of self-reported surveys but the primary focus of the paper included additional factors; physicians' health beliefs, patient, geographical, international and primary care influences. The majority [4] of the studies were from the US, with one comparing US and French GPs, one paper from Canada and two from the UK (Northern Ireland and England).

Haas *et al.* (2007) draws data from both GP and patient surveys. 64.8% of GPs reported being compliant with recommended screening interval but with the addition of patient survey data it turned out that only 37.4% had in fact been compliants.

Studies of geographical influences found that more GPs in rural areas reporting using some form of guideline compared with urban GPs (Santora *et al.*, 2003a), though one Canadian study (Haggerty *et al.*, 2005) found there no difference between rural and urban practices. Socio-economic factors were found to play a significant part in access to screening in Haas *et al.* (2007) with patients of non-white ethnicity, specifically Hispanic, and of a lower level of education less likely to be screened for colorectal cancer. Once screened, however, these inequalities disappeared and no demographic factors had a significant impact upon their access to continual routine screening. Patients in areas of high socio-economic status had better access and more diagnostic options available to them and GPs in these areas are significantly more experienced than GPs in low SES areas (Gorin *et al.*, 2007).

The personal beliefs and demographic characteristics of the GP were found to have an influence. Younger and female GPs are significantly more likely to recommend breast cancer screening (Santora *et al.*, 2003a) while PSA testing is more commonly recommended by male GPs (Gormley *et al.*, 2006). A study by Shieh *et al.* (2005) found an association between GPs' own participation in colorectal cancer screening and recommendations to patients to participate. Older GPs (those over the recommended colorectal screening age of 50) were more likely to have participated in screening, while younger GPs who were identified as high risk, were significantly less likely to have participated in screening. Self-reported compliance with guidelines was particularly high in this study, with 91.3% of GPs saying they followed guideline recommendations.

Sorum *et al.* (2003) surveyed and compared responses between US and French GPs with regard to prostate cancer screening and found that the two groups differed significantly on a number of points. In particular the US GPs ordered significantly more routine PSA (Prostate-Specific Antigen) tests, many for healthy patients with no signs or symptoms. The authors attributed this to the US GPs reporting feeling greater pressure from healthy patients requesting tests, fears of malpractice law suits and fear of missing a diagnosis. Pressure from patients was also reported in a second study (Haggerty *et al.*, 2005) which found almost 90% of GPs reporting that patient anxiety and/or expectation of being tested influenced their decision to order a cancer screening test they would not usually recommend.

All studies in this section, while still using self-reporting data, additionally examined other factors that could influence screening beliefs and practice. Again the number of respondents in each study vary widely (n = 65(Sorum *et al.*, 2003) – 12,727(Haas *et al.*, 2007), mean n = 2,088.57) and the response rates ranged from 9 – 80.5(Sorum *et al.*, 2003)% (mean = 59.14%).

3. 9. 2. Organisational

These studies mainly examined the impact of financial incentive schemes and their potential to improve quality/performance. Gavagan *et al.* (2010) examined the effect of a financial incentive system implemented in two medical schools in the US on cancer screening but found no significant differences between incentivised and non-incentivised groups in their meeting of quality criteria. In the case of mammograms both groups improved in their meeting of quality criteria but there was a non-significant trend in pap tests where the incentivised group improved in meeting quality criteria but the non-incentivised group remained reasonably constant. Despite the study failing to show an effect, 70% of the GPs involved felt that the scheme was very or extremely effective in improving quality.

Two of the studies used data from QOF, one examining the effect of practice size (Wang *et al.*, 2006) and the other looking at population demographics (Downing *et al.*, 2007b). The former of these found that practice size in Scotland (n = 636 practices) had a significant effect upon the total QOF points attained, with smaller practices attaining fewer points than larger practices. On closer investigation it was found that the significant difference was solely attributed to QOF factors in the organisational domain, so the quality of clinical care was no different. Interestingly it was found that smaller practices had high prevalence levels of cancer and were more likely to be located in areas of socio-economic deprivation and have a higher percentage of ethnic minority patients. Downing *et al.* (2007b) also found that deprivation had an effect, finding an association between increasing deprivation and increased mortality and hospital admission rates. The key finding of this study however was that when two PCTs (n = 516,620 combined patient population and n = 94 combined practices) were compared, higher clinical domain scores in QOF were significantly associated with fewer emergency admissions for cancer. This could

be interpreted as a demonstration of good quality care from GPs leading to more cases of cancer being identified and at earlier stages.

In relation to referral rates Hippisley-Cox *et al.* (1997) aimed to look at the potential association between low referring practices and later stage of cancer at diagnosis. No association was found suggesting that low GP referral rates do not result in adverse outcomes for the patient, however the number of cancer cases used in this study were not particularly high (breast cancer n = 131, colorectal cancer n = 300).

Overall these studies showed mixed results to the use of financial incentive schemes, while Downing *et al.* (2007b) found improvements in cancer outcomes in the form of reduced emergency admissions, Gavagan et al (2010) did not find any improvement to cancer screening after the introduction of an incentive scheme. Equally GP practices' performance in such schemes is significantly affected by the size of the practice and socio-economic and demographic factors.

3. 9. 3. Clinical guideline adherence

Like the earlier group of self-reported guidelines adherence this group of studies all have the primary outcome measure of GPs' adherence to guidelines. The primary difference is in the methodology used in all the studies where instead of self-reporting surveys a physical measure is used, such as patient records, screening uptake rates or practice audits etc. This means that potentially the quality of the studies is better because the measurement of quality is a physical outcome and therefore more accurate than a belief or perception. The studies have been further divided by the type of guidelines as there were studies which focused on guidelines for referral and excision of skin lesions and those relating to screening guidelines.

3. 9. 3. 1. Screening

Of the three studies two were from the US (Parkerton *et al.*, 2003, Hoffman *et al.*, 1998) and one from Mexico (Salinas *et al.*, 1998a) and they cover PSA testing, smear tests and colorectal screening.

Salinas *et al.* (1998b) examined the number of smear tests conducted and the quality of the tests, test results were measured against national and international parameters in an area where an early detection programme had been running. Urban and rural practices were compared for smear test sampling quality and these were significantly different, with urban practices performing better. The quality improvements that were anticipated were not achieved by either urban or rural practices, for example in urban practice 64.2% sampling quality was expected but only 38.5% was attained. This suggests that guidelines relating to the execution of smear tests is not being met. It was also noted that a higher than expected number of women over 25 had not previously received a smear test which again suggests that guidelines related to early detection testing are not being followed and met.

A study of PSA testing by Hoffman *et al.* (1998) using patient records and the US cancer registry found widely varied screening practices from guidelines. 15.7% were tested outside of the recommended age range and 23.7% of patients, once tested were retested within six months, contrary to guidance, demonstrating that guidelines for PSA testing were not followed by a substantial minority.

An analysis of GP screening rates in association with whether the GP worked full or part-time was conducted by Parketon *et al.* (2003). In terms of cancer screening it was found that part-time GPs had significantly higher rates of screening. While this did not impact upon patient outcomes, which were measured by patient satisfaction; diabetes

management, cancer screening and ambulatory costs and association between working part-time and quality of care was. Patient and GP satisfaction were both higher in part-time GPs.

The size of each of these studies varies (n = 194(Parkerton *et al.*, 2003) – 1,500(Salinas *et al.*, 1998a), mean n = 1,047.33). All three studies are older pieces of research, 1998 (Hoffman *et al.*, Salinas *et al.*) and 2003 (Parkerton *et al.*) however, what the former two studies show is that guideline adherence is low and varied compared to GPs self-reporting of their behaviour and adherence. Even since 2003 there have been many changes and updates to guidelines and practice and the lack of more current research which uses better quality data from patient records etc. highlights the gap in this research area.

3. 9. 3. 2. Referrals

There are five studies covering colorectal, breast, skin and prostate cancer, all from England. Within the UK there are guidelines for referrals, specifically if a patient presents with a number of red flag or alarm symptoms then they would be placed on an urgent referral pathway (for select cancers, such as breast, this is known as the two week wait).

All studies reported that guidelines were not being followed, ranging from 37.66% of the sample cases not adhering to guidelines (Debnath *et al.*, 2002), 48% (Webb and Khanna, 2006) and 52.5% (Khawaja and Allan, 2001). Melia *et al.* (2008) studied the effect of a change in prostate cancer referral guidelines for asymptomatic patients. They found that changes in GPs' referral patterns were low and significantly lower than expected suggesting that GPs were not aware of and/or adhering to the new guidelines.

John *et al.* (2007) surveyed GPs (57% response rate) about their knowledge of referral guidelines and combined responses with the referrals rates for the practice. Only 58% reporting being primarily influenced in their referral decisions by guidelines and while 78%

of surveyed GPs reported being aware of guidelines only 8% could correctly answer one of the survey questions about fast-track criteria for colorectal cancer. A high variability was observed between practices with 53% of practices not using the two week wait referral pathway for colorectal cancer and a significant association was found between use of the two week wait pathway and higher incidence of colorectal cancer. It is suggested this could be because GPs are identifying alarm symptoms and correctly referring patients rather than a diagnosis being missed and patients entering through emergency hospital admissions.

Debnath *et al.* (2002) observed that in GPs and practices where compliance to guidelines is high there are more frequent diagnoses of cancer. This could suggest that GPs who are not following guidelines are missing incidences of cancer.

In both Khawaja and Allan (2001) and Webb and Khanna (2006) it was reported that a high number of GP referrals were not meeting guidelines. In the latter, a review of patient referral letters for skin lesions was carried out and found 41.58% of the referrals written by GPs gave no indication of priority, while 22.41% of the urgent/two week wait referrals did not meet guidelines. In the case of Khawaja and Allan (2001) referrals to the fast-access breast clinic should only be made if a new breast lump was found, however, in 20% of the referrals from GPs in this study no new breast lump had been presented by the patient. Where GPs had indicated a breast lump in the referral, only half actually had a lump.

This group of studies is a mixture of qualities, with study numbers ranging from 100 patients – 17,000 patient records. The majority were short studies of a year or less (Debnath *et al.*, 2002, Khawaja and Allan, 2001, Webb and Khanna, 2006, John *et al.*, 2007) while Melia *et al.* (2008) was a continuation of a study following the launch of amended guidelines in 2002. Some studies employ and report suitable statistical methods and analysis (John *et al.*, 2007, Melia *et al.*, 2008, Debnath *et al.*, 2002) while the remaining studies (Khawaja and Allan, 2001, Webb and Khanna, 2006) simply report percentages,

standard deviation and means. In these latter two studies, while guidelines are used as part of the framework to assess quality and appropriateness of GP cancer referrals there is also an element of a specialist's interpretation and opinion. For example, in Khawaja *et al.* (2001) the presence of a breast lump is taken as the measure of whether a referral is appropriate and while 80 patients were referred with a lump it was later determined only 42 had an actual lump. In this case, what is a lump? If a patient is presenting to their GP and reporting that something is abnormal but which a specialist later says it is not a lump but a benign breast change, who is right?

3. 9. 3. 3. Excisions/diagnosis

All four studies are from the UK (three from England and one from Wales); three use excision margins in melanoma/skin tumours as the measure of quality and one looks at the accuracy of a GP's diagnosis after excision (Pockney *et al.*, 2009). Two of the studies are long-term (one is eight years (Neal *et al.*, 2008a) and the other 17 years (Bakhai *et al.*, 2010) retrospective analyses of patient reports. Significant differences in the quality of excision were observed in both studies between specialists and GPs, with GPs not performing as well; specifically having narrower excision margins (therefore the whole affected area may not be removed). This pattern was supported by Goulding *et al.* (2009) who in their three month retrospective review found that against specialists, GPs did not perform as well but also failed to meet guidelines. In particular 13.8% of the excisions performed by GPs should have been referred, according to NICE guidelines. It would be expected that GPs would not perform as well against specialists; however, a demonstration that GPs are not meeting guidelines is of interest and a measure of quality.

Bakhai *et al.* (2010) additionally highlighted in their study that improvements in excision margins across specialists and GPs were observed after the introduction of new

guidelines; however, guidelines outlining that primary care excisions by GPs should be avoided had little or no significant impact on the number of excisions carried out by GPs. This was not supported by Neal *et al.* (2008a) who observed a decline in excision of lesions in primary care.

Pockney *et al.* (2009) in a retrospective study examined the accuracy of the GPs' diagnoses and their adherence to guidelines. It was found that GPs' diagnostic accuracy was poor with less than half the lesions which GPs diagnosed as malignant turning out to be. Equally there was a small number which GPs had identified as benign which were later diagnosed as malignant, but these missed lesions accounted for a third of the total malignant lesions in the study. It should be noted that the vast majority, 85% of the sample lesions were accurately diagnosed as benign by GPs (91% when accurately diagnosed malignant lesions are added). In Pockney *et al.* (2009), and in Goulding *et al.* (2009), decisions regarding whether guidelines had been met were in some parts of the analysis made by specialists retrospectively reviewing cases. As previously highlighted, specialists are more accurate and therefore including their input in analysis as to whether GPs have correctly identified malignant cases or followed guidelines correctly, could exacerbate findings.

3. 9. 4. GP influences

The remaining three studies are a mixture from Ireland (Daly and Collins, 2007), the US (Carney *et al.*, 1993) and a comparison of UK and Australian GPs (Jiwa *et al.*, 2008)

Jiwa *et al.* (2008) used questionnaires with structured vignettes, based upon referral guidelines, to compare the referral behaviour of English and Australian GPs (response rate – 52%, n = 260). It was observed that there was no significant difference between the two

countries and just over half of the vignette cases were placed on the correct pathway, but a higher than necessary number were placed on the urgent pathway.

Daly and Collins' (2007) focus was upon GPs' perceived barriers to patient cancer diagnosis. This is important to include within this review as it shows factors that could be affecting GP quality. In particular from the survey (response rate - 46.7%, n = 929), the lack of clear screening recommendations was highlighted by GPs as were long waiting times for patients sent on urgent referrals. 20% of the GPs surveyed reported that patients had to wait longer than two weeks for an urgent appointment. Lack of access to hospital screening services, longer waits for non-private patients and poor communication with hospital services were also highlighted. No attempt was made in this study to see if there were any significant differences, all analyses were simply numbers and percentages.

Finally Carney *et al.* (1993) is a novel approach to assessing GP quality as they used a standardised patient to present cancer risk family history to see if GPs would follow guidelines and recommend screening. It was found that the offering of screening was based upon the cancer type, with breast cancer mammograms being offered by almost all GPs but checking for oral cancer was only done by a few. Guideline recommendations were not consistently met, or as highlighted above, some services were not provided; equally recommendations regarding lifestyle such as smoking cessation were not universally given despite guidelines stating such a recommendation. This is a unique study in that the method of assessing GP quality is particularly novel, but is not 20 years old.

3. 10. Discussion

This review demonstrates that GP practice quality for cancer has been assessed in a number of ways with varied outcomes and findings. Adherence to guidelines, through whatever method, is the most common outcome measure of quality (30 of 37 studies) and these are in general agreement that GPs do not fully comply and adhere to cancer guidelines, from screening through to diagnosis with percentage compliance ranging from 10.6%(Stokes-Lampard *et al.*, 2005) – 91.3%(Shieh *et al.*, 2005). What has also been found is that a range of factors influence GPs' adherence to guidelines and referral practice. In particular GP demographics such as age (Pendleton *et al.*, 2008, McGregor *et al.*, 2004, Roetzheim *et al.*, 1991) and specialism (Yabroff *et al.*, 2009), geographical location (Santora *et al.*, 2003a, Pendleton *et al.*, 2008), patient influences (Sorum *et al.*, 2003, Haggerty *et al.*, 2005) and the type of cancer (Ka'ano'i *et al.*, 2004, Smith and Herbert, 1993) seem to be associated with GPs' decision and practice to screen for cancer, make referrals etc. Interestingly in studies with longitudinal data it was observed that after the introduction of new/updated guidelines, GPs' practice and compliance improved (Salinas *et al.*, 1998a, Melia *et al.*, 2008, Bakhai *et al.*, 2010, Neal *et al.*, 2008a) suggesting that guidelines do in themselves have an impact on GP behaviour but are possibly confounded by the above-mentioned additional influences.

Developing a suitable and accurate measure of quality is clearly a complex issue and large scale attempts such as the introduction of quality assessment and financial incentive schemes have, particularly in England with QOF, been a major health care reform. While they have had an influence upon how GP practices operate and GP behaviour, it was surprising that only two studies (Wang *et al.*, 2006, Downing *et al.*, 2007b) were identified through the search strategy.

It could be suggested that QOF has not been in place and operating for an adequate length of time to be used as a research data source; however, at the time of this review QOF had been in place for over five years and neither of the papers included in the review were recent (within the last five years) studies (2006 and 2007). Another suggestion could be that researchers are simply unaware of what data is available from the NHS information centre, this issue was recently highlighted by Curcin *et al.* (2012), who identified that NHS data was not utilised to its best due to it being unclear as to what was available and its provenance. Despite this, QOF data has been and is, regularly used within healthcare research (Kiran *et al.*, 2010, Ashworth *et al.*, 2007, McLean *et al.*, 2006, Wright *et al.*, 2006, Strong *et al.*, 2006, Sigfrid *et al.*, 2006), and while it has been used in cancer research it is often limited to investigations into prescribing behaviours and hospital admissions (Bottle *et al.*, 2012, Rowlingson *et al.*, 2013, Ashworth *et al.*, 2007, Downing *et al.*, 2007b, Iyen-Omofoman *et al.*, 2011). It has been identified as a limitation for cancer research that QOF has a small number of indicators, presently three, which are cancer specific. Therefore, the lack of papers relating to cancer and GP quality that utilise QOF may be indicative of this limitation as to the validity and practicality of QOF as a quality measure for cancer. Equally this could simply indicate that there is a lack of research in this area that needs to be addressed.

Almost half (18 out of 37) of the studies used a self-reporting methodology to investigate whether GPs were adhering to cancer screening guidelines. This cannot be considered a rigorous methodology and in a number of the studies either no statistical analysis was used or was inadequate (Smith and Herbert, 1993, Ka'ano'i *et al.*, 2004). Studies which used a physical measure of guideline adherence, generally the use of patient and GP practice records (12 of 37 studies), were of better quality with more rigorous methodologies; however, there were some biases. Specifically it had been previously identified that there are a number of studies which, in their method to assess whether GPs

had made referrals and excisions/diagnosis correctly were simply reviewed by specialists as a method of analysis, or in fact the accuracy of excisions etc. by GPs and specialists are compared.

While these types of studies were excluded, there were studies included in the final papers where specialists had reviewed GPs' referrals etc., but GPs' and specialists' actions were also compared to current guidelines (Bakhai *et al.*, 2010, Goulding *et al.*, 2009, Neal *et al.*, 2008a, Pockney *et al.*, 2009, Khawaja and Allan, 2001, Webb and Khanna, 2006). This inclusion of comparing against guidelines does aid in reducing any bias or personal opinion that specialists may have, but equally it was not always part of the primary aim or analysis; for example, in some papers (Khawaja and Allan, 2001, Webb and Khanna, 2006) the use of guidelines in the analysis was secondary or simply a tool which specialists used in their review of GP referrals.

What is most clearly demonstrated by this review is not only the varied way in which GP and primary care quality has been assessed but also the wide range of factors that influence the quality of care and services provided. Generally the quality of studies in this review was poor, with many using limited methodologies and analysis. Fewer studies were from within the last five years (2007-2011, n = 14) and the majority were from the UK and US (UK n = 15, US n = 14).

3. 10. 1. Strengths and weakness of the review

This is an area which has not previously been subjected to a systematic review. More than one database was used and while there was an expected level of overlap between the two databases, due to their specialism in medical and biomedical research, there were a number of papers reviewed which came from just one database. Equally the search strategies, despite not being consistent due to the highlighted problems of different

terminologies between the databases, did produce a number of articles which were found in both databases from using the respective strategies for each database.

The inclusion/exclusion criteria developed were also effective in identifying appropriate articles, as through the second review process, while some articles needed discussion there was a general agreement on the studies meeting the inclusion criteria between the reviewers. The inclusion of a second reviewer process was a strength of this review, as it meant that reviewer bias etc. was reduced.

Once the final papers were agreed upon, the reference sections of each paper were hand searched and any potential papers reviewed against the criteria and by the second reviewer. This helped to identify an additional three papers which were included in the final review.

Unfortunately due to the nature of the studies this had to be a narrative review, as it was not possible to conduct a meta-analysis due to the varied and mixed outcome measures of the studies. As a result of this varied nature the use of an established quality checklist was not deemed to be appropriate to use to more rigorously assess the quality of the final studies. However, these limitations of the review in themselves highlight and establish the limitations and mixture in the level of quality and lack of sufficient and consistent research in this area.

3. 10. 2. Implications and future research

This review has highlighted the lack of clear and consistent measures of GP practice quality; this is a problem as current and future health care priorities move towards improving the quality of primary care. GPs' adherence to guidelines was most commonly used as an outcome measure, but the majority of studies which used this as a quality measure were using GPs' self-reported adherence, which could differ from their actual

adherence. In countries such as the UK where quality monitoring schemes are in place, such as QOF, there is a distinct lack of studies which utilise this data source for research.

It is therefore recommended that future research should be focused upon utilising such data sources and established frameworks of quality assessment, rather than simply relying on GP self-reporting surveys, to improve the quality of future studies and provide a more accurate and unbiased measure of primary care quality.

This review also found that a number of external factors affected GPs' provision of quality care and influenced their decisions in areas such as screening and referrals, these ranged from the GPs' personal beliefs and characteristics (Parkerton *et al.*, 2003, Xilomenos *et al.*, 2006, Shieh *et al.*, 2005) to patient pressure and demographics (Sorum *et al.*, 2003, Gorin *et al.*, 2007). Further research into the effect of these factors and how they contribute, or hinder, the delivery of quality primary care is also recommended.

4. Chapter 4 – methods

This chapter will outline the methodology used for this research. The aim of this research is to test the hypothesis that a patient's cancer stage at diagnosis is influenced by the GP practice they attended, specifically by how that practice performs on certain quality measures. This research was funded as part of an e-health project, therefore part of the aim is to obtain and use data from existing health databases and possibly combine health databases together. The consideration about what databases and sources were available and could be utilised for this project, are discussed within this chapter.

There were a number of new and unique issues that arose throughout this part of the research. Once the decision regarding which health sources and databases was made, the process of obtaining ethical approval, preparing the data, merging databases together and putting together a plan of analysis had to be organised and the challenges of these processes is discussed within this chapter.

4.1. Theoretical considerations

The systematic review and general exploration of literature and research in this area raised some factors that required consideration and impacted upon the approach and methods used in this research.

From the systematic review it became clear that measuring quality of care is a complex and varied issue, and it bought into question whether QOF was the best choice as a measure of primary care quality.

In the UK, traditionally responsibility for quality of care has been in the hands of the individual GP and professional bodies, such as the Royal College of General Practitioners (RCGP) (Birch *et al.*, 2000, Scrivens, 1995, Scrivens, 2002). In the latter part of the 1990s quality improvement in the provision of health care became a high priority on the agenda in the UK and internationally (Campbell *et al.*, 2003, Campbell *et al.*, 2000). What followed was a large amount of investigation and research into quality of health care, how it could be measured and the development of a national performance network within the NHS.

Ultimately such research led towards the development of a financial incentive scheme, whereby GPs had to hit certain health targets and for doing so received additional funding/financial reward for their practice. The Quality Outcomes Framework (QOF) was introduced in 2004 and is the current scheme which measures primary care quality in England. QOF is a voluntary annual programme for all GP surgeries in England but despite the scheme being voluntary in 2009/2010 over 8,000 practices in England took part, which is 99.7% of registered practices. QOF measures achievement against 134 indicators, across clinical care, organisational, patient experience and additional service domains. In the case of the clinical indicators many of these reflect health conditions and diseases which are of priority, such as coronary heart disease, hypertension, COPD and diabetes. Between

2008/2009 the average achievement in England was 95.4%, with 2% of practices within England achieving 100%.

In their review of QOF in the three years since its introduction, Doran *et al.* (All Party Parliamentry Group on Cancer Report, 2009) in their report found that in the first year deprivation was associated with low achievement in quality of care and therefore causing inequalities. In the subsequent two years, achievement in these areas has increased, suggesting an improvement in tackling inequalities as a result of QOF. In mental health research QOF has been found to be a useful and valid tool for measuring and assessing the delivery of health care services (Ivbijaro *et al.*, 2008).

McLean *et al.* (2006) have also highlighted the benefits of QOF for tackling inequalities as there are systems in place, in particular the exclusion system, which reduce the risk of practices being penalised because of the populations they serve. In contrast Sigfrid *et al.* (2006) in their research on diabetes and QOF found that practices located in more deprived areas were more likely to report exceptions. As a result this could suggest that within these populations there are unmet needs being disguised by selective reporting, as practices try to gaining additional funding. Following from this there is a well recognised positive bias within QOF, with many practices achieving the maximum score to receive maximum funding (Doran *et al.*, 2014).

Questions about the validity of QOF have arisen. Downing *et al.* (2007b) examined hospital admissions and their relationship to QOF. They found that QOF scores were not linked to the rate of hospital admissions, which appears to be counter intuitive as the pattern we would expect to see is that as quality of care improves, hospital admissions should reduce. Short (2007) also highlighted that the guidelines QOF outlines, particularly in smoking cessation, do not match those of other quality organisations such as NICE.

Prior to the implementation of QOF practice quality there was a lack of standardised methods that assessed the quality of health care (Thiru *et al.*, 2003). If practice quality was investigated it would probably have used Membership of the Royal College of General Practitioners (MRCGP) as a measure. By using information about which practices are engaged in training and CPD schemes the assumption is that those practices taking part in such schemes have a desire to improve quality. However, within research this has not been a widely used measure and it could be easily argued that engagement in training is not necessarily a measure of current good quality health care.

Therefore, databases such as QOF are beneficial resources for research and for this specific research project there is a need for a quality measure that is used and consistent across a wide number of GP practices which QOF provides. However, it is important to remember that good quality documentation does not equal good quality care (Heath *et al.*, 2007). There are a number of arguments which must be acknowledged that highlight and express that quality of care can never be adequately measured or that wide-scale quantitative measures such as QOF cannot capture important aspects of quality such as patient/GP communication (Becher, 1999, Howie *et al.*, 1999), but an attempt to incorporate these factors is outside the scope of this research and is not possible at this time.

In addition to more careful reflection of appropriate measures of quality of care, more exploration was required of the decision to use cancer stage at diagnosis as the outcome measure. As previously discussed, in chapter 2, this was a novel approach at the start of this research, previously cancer records of staging information have been mostly incomplete and poor; however, it has become more commonplace to use cancer stage at diagnosis as an outcome measure within research (Forrest *et al.*, 2014, Lyratzopoulos *et al.*, 2012a, Rutherford *et al.*, 2013).

This more recent work has highlighted the need to consider factors that could influence cancer stage at diagnosis as a measure, specifically the variation between cancer types in consultation and referral rates (Lyratzopoulos *et al.*, 2013). Between breast and colorectal cancer there are a number of differences regarding their primary care interval, with colorectal patients receiving a higher number of consultations prior to diagnosis and higher primary care referral and interval times. Tørring *et al.* (2013) in their Danish cohort study reflects these variances in interval time, with breast cancer having a shorter primary care interval compared to colorectal cancer.

Equally it must be kept in mind that while the focus of this study is on GP quality of care and cancer stage at diagnosis there are a number of factors that can contribute to cancer stage. As previously mentioned in chapters 2 and 3, age, sex, ethnic origin, socioeconomic status (Downing *et al*., 2007, Cutherbertson *et al*., 2009, Delmothe, 2008, Conway *et al*., 2007, Johnson *et al.*, 2008, McLean *et al.*, 2006) increase the likelihood of developing cancer but also influence diagnosis and treatment. Other forms of delay, such as patient and system delays as outlined in the model by Andersen *et al.* (1995) can also contribute to delays in diagnosis. Not all of these factors are measurable, and in some cases are beyond the scope of this research, however where it has been possible to request data regarding these factors they have been included, for example, patient age and sex, and income domain quintile as a measure of socioeconomic status.

Breast and colorectal cancer differ widely and these differences in consultation and interval rates between breast and colorectal cancer support and highlight the decision to separate the dataset and analyse the two cancer types separately as they are not comparable; therefore, any comparison that could be made would not be of benefit for future research and policy.

4. 2. Databases

This research only used data from pre-existing databases, no new data was collected. The databases that have been used in this study are as follows:

- Cancer related data came from the Northern and Yorkshire Cancer Registry and Information Service (NYCRIS). Specifically the data that was extracted included; patient's cancer type, cancer stage at diagnosis, year of diagnosis, GP practice, sex, age and deprivation index.
- Practice quality data was obtained from the practice profiles, which covers the Northern and Yorkshire region. Practice profiles are available via the Association of Public Health Observatories (APHO) website, this data is in the public domain. The specific data that was extracted included; all variables related to cancer, local area and practice deprivation index scores, practice demographics and patient satisfaction scores.
- Quality and Outcomes Framework (QOF) data was also included, this is included in the practice profiles but where specific indicators or practices were missing the most recent QOF data from the NHS Information Centre website was obtained. This is publically available data that is freely available to download.

NYCRIS is one of eleven cancer registries around the UK, which routinely collect cancer data from multiple sources. In addition to collating local cancer information, cancer registries work with a range of organisations within their area, i.e. PCTs, SHAs and cancer networks and national organisations, such as the ONS, to produce health and care publications. NYCRIS covers a large geographical area of Northern England and Yorkshire (excluding a small area of South Cumbria) with a total population of around 6.6million with over 50,000 new cancer cases recorded per year. Further details about NYCRIS are available via the NYCRIS website (http://www.nycris.nhs.uk/).

Through discussions with NYCRIS it was suggested that two or three specific cancers were selected for analysis, the reason for this was primarily two-fold. Firstly by selecting just two or three types this would simplify data management and analysis but also more common and priority cancer types can be focused on, which also ensures a sufficient number of cases for analysis. Secondly the recording of cancer stage is not consistent across the cancer types, for example it had been hoped that lung cancer could be included in this research, because of its prevalence and high mortality rate which therefore has made it a priority within cancer targets. However, the number of cases which had a stage recorded was very low (less than 10%). In comparison breast and colorectal cancer, which are both prevalent and priority cancers, had at least 70% of cases with a cancer stage recorded, specifically colorectal cancer had 25.9% of cases with an unknown stage and breast cancer was 7.3%.

Currently there are a number of methods by which cancer stage can be recorded; specifically for colorectal cancer, Duke's staging is the common method but for breast TNM is the more common staging method. Cancer registries within the UK are managed by the Office of National Statistics (ONS) which collates information from the registries to produce national statistics. When cancer registries submit cancer stage information, regardless of the cancer type, they use a standardised system which is as follows;

0= In Situ

1= Local Involvement Only

2= Extension to Adjacent Tissues

3= Lymph Node Involvement

4= Metastases

5= Unknown

The NYCRIS data fields requested included patients; sex, type of cancer (breast or colorectal), stage of cancer at diagnosis, age at diagnosis, patient-level income domain score (which was provided in quintile, with 1 being the least deprived and 5 the most deprivied), year of diagnosis and the patient's GP practice code for the previous three years (2006-2008). In the event of missing data it was requested that these cases not be excluded, just that whatever information in the requested fields was included, this was to try and keep numbers for analysis as high as possible but to also record and observe where missing data was most commonly occurring.

After the data had been obtained it was decided that information related to whether patients had been diagnosed through a screening pathway would be of benefit. Diagnosis via screening bypasses the GP practice and therefore cases diagnosed in this way would only obscure and bias the results. Screening information for the 2006-2008 period was requested and received, but this was only available for breast cancer. The NHS Bowel Cancer Screening Programme in England started in July 2006, this was for men and women aged 60-69 to whom an invitation for screening was automatically sent through the post, if they were registered with a GP. However, within the Yorkshire region this programme was only partially rolled out in 2006 and as a result screening information regarding bowel cancer was not available.

The APHO is made up of 12 PHOs around the UK that collate and produce information, data and intelligence on people's health and health care for practitioners, policy makers and the wider community. A recent initiative has been the production of practice profiles, designed to assist GPs, emerging consortia and PCTs to ensure that they are providing and commissioning effective and appropriate healthcare services. Information from a range of sources, specifically QOF, GP patient survey data, the Attribution Data Set and Primary care

mortality data, was collated to produce these profiles which provide data regarding the practice population, deprivation, measures of quality etc. Where possible the most recent data was used, in the case of this research that was data from 2010. At that time it was reported that 3% of practices in England were not included in QOF results, this was either because the practices had chosen to not participate in the QOF scheme or the practices had small list sizes so were excluded on this basis. The profiles became publicly available in late 2010 and were reviewed in mid-2011. The practice profiles are available through the APHO website (http://www.apho.org.uk/pracprof/).

QOF data is a primary component of the APHO practice profiles. QOF is a voluntary annual reward and incentive programme for all GP surgeries in England. It was introduced as part of the GP contract in 2004 and despite the scheme being voluntary, in 2009/2010 over 8,000 practices in England took part, which is around 99.7% of registered practices. QOF during this time period measured achievement against 134 indicators, across clinical care, organisational, patient experience and additional service domains. The more points and therefore higher score that GP practices achieve the more money they receive but adjustments are made based on the practice's workload and the proportion of chronic conditions within the local area. Results from QOF are available through the NHS information centre website (http://www.qof.ic.nhs.uk/index.asp). In addition to the data which was obtained from the practice profiles the individual domain scores and overall total QOF score for each practice was obtained from the QOF website for 2010.

It should be acknowledged that there is a distinct difference between the two primary sources of data. While data from NYCRIS is at an individual patient level, the data from the APHO etc. is an aggregation of a group of patients within a practice. Therefore, the data being used to measure practice quality may not accurately reflect an individual patient's experience of quality of care. Equally there is the risk of generalising results which have

limited power when using organisational level data, such as practice measures of quality. Saunders & Abel (2014) highlight this issue using the example of hospitals within England; with only 160 hospital in England even the inclusion of all of these within an analysis would give good but limited power to a study. Walker et al. (2013) support this identifying that surgeons may not conduct a sufficient number of specialists procedures within a year for the quality of patient outcomes to be adequately measured and therefore could lead to and result in false reporting.

There is a much greater number of GP practices within England however, and this research project has looked at a large geographical area, capturing 792 GP practices in the colorectal cancer dataset and 840 in the breast cancer dataset. Had these numbers been smaller a greater exploration of power and the use of organisational group measures would have been necessary and adjustments or alternative designs would have been explored; further discussion on this can be found in Chapter 6.

4. 3. Ethical approval

The practice profile data and QOF data which came from the APHO and NHS websites are both publicly accessible and the data is freely available to download.

In contrast data from NYCRIS is not publically available and therefore a formal data request was made. While no patients were being directly recruited or contacted for this research project, data from NYCRIS is classed as potentially identifiable data, specifically as a geographical identifier (GP practice) and details regarding the type and stage of cancer at diagnosis were requested. This level of detail means that individual cases could be potentially identifiable particularly where there are a small number of cases within a practice.

Due to the use of patient data, NHS REC (Research and Ethics Committee) approval was required. However, because of concern regarding the issue of potentially identifiable data the NIGB (National Information Governance Board) was contacted prior to ethical submission. With their help, adaptations were made to the design of the study to ensure that patient information was sufficiently anonymised and could not be identified.

In particular the NIGB were concerned with small numbers, where within a GP practice there were less than five cases of a specific type of cancer, e.g. three cases of breast cancer or four cases of colorectal cancer. In these cases the NIGBs required changes were to amalgamate some patient information and data, specifically patient's age and the year of diagnosis, to reduce the identifiability. How these changes and ethical stipulations altered and affected the data are discussed later in this chapter.

Once these changes were made to the design of this study an ethics application was made to the NHS REC and approval was granted, see appendix 1.

4. 4. Working with the data

Once all data was obtained it became evident that a process of data preparation and cleaning was required before all the data could be merged together into a cohesive dataset, before analysis could take place.

The decision was made to combine all three years of data, rather than keep each year of diagnosis separate for analysis; this was in line with the NIGB changes to anonymise the data. By amalgamating all years together it avoided a large number of practices from being excluded from the analysis because of small numbers, based on the guidance and stipulations set by the NIGB, that had to be met to gain ethical approval. It was also observed that a small number of patients were diagnosed at a young age, which could have again caused an issue of small numbers. To resolve this, existing age ranges were combined

into broader age categories. Specifically two age categories were used; working age (18-64) and retirement age (65+), this ensured that NIGB stipulations were followed and prevented a number of patient cases and practices from being excluded.

Previous research has combined and grouped cancers together (Howlader *et al.*, 2010, Jemal *et al.*, 2011) and this was considered as an option for this research; however, it was eventually decided that the two cancers should be analysed separately. This meant creating two datasets for analysis, one for breast cancer and the other for colorectal cancer. In light of this it was decided that in addition to the ethics committee requirement that a minimum of five cases must be present, it was appropriate to additionally remove any small numbers within cancer type. For example if a practice had a total of 13 cases but 11 of these were breast and only two were colorectal then the colorectal cases were removed. However, the breast cancer cases for that practice could remain in the breast cancer dataset, as there were more than five cases.

After obtaining the data it was decided that the inclusion of information related to screening would be of benefit. NYCRIS does hold information related to screening but this is not 100% complete. Also for the time period of 2006-2008 the national breast screening programme was running but routine screening for colorectal cancer had not yet been introduced. Therefore screening information was only available for breast cancer during this time period.

The NYCRIS screening data comes from the NHS Breast Screening Programme which is a population screening programme inviting all women between the ages of 50 and 70; an invitation is first sent between the ages of 50 – 53, for routine mammograms every three years. Around 1.5 million women are screened every year at screening units across the country. The programme is aimed at asymptomatic women. Due to limitations in the

mammography technology it is not suitable/as accurate for younger women, therefore this group would most likely be presenting and be entering diagnostic pathways via their GPs.

The screening programme is monitored and checked for quality and this is overseen by regional Quality Assurance Reference Centres (QARCs). These centres collect and collate data about the performance and outcomes of the breast screening programme, organise quality assurance visits and provide support for the regional director of quality assurance and the professional coordinators.

Knowledge of screening status is important because detection through screening is not done via a GP. Therefore it can be argued that the quality of practice of a patient with screen-detected cancer has not influenced the stage at diagnosis. Therefore by knowing which cases have been detected via screening, they could be isolated or excluded from the analysis.

The screening categories that were provided by NYCRIS are wide ranging and detailed. Definitions of the categories were gained from NYCRIS and from the QARC and a breakdown of the ten categories is as follows:

1. Screening detected cancer – the diagnosis has been made from the screening process not via the GP or other routes.
2. Interval cancer – the diagnosis has been made between screening episodes, so the patient is attending screening and their last result was negative but has presented with symptoms prior to next scheduled screening.
3. Cancer in non-attender – patient has never attended any screening despite being invited, so has presented via another route.
4. Overage – patient is over the age range for screening at the time of diagnosis, according to QARC they would also have attended their last screening (so should

not be any non-attenders in this group). NYCRIS say that in fact these are screen detected cancers where the patients has requested to continue screening after the age of 70.

5. Cancer in lapsed attender – attended at least one round of screening but did not attend their last scheduled screening prior to diagnosis.
6. Cancer in uninvited – patient has not been invited for screening, but not underage. QARC say this is most likely because they are close to screening age (50-52) but recently moved so the invite is lost and NYCRIS said something similar and added that input errors on the records system can also result in eligible individuals not being invited.
7. Underage QARC – Patient is under the age range for screening at time of diagnosis, QARC says it is women aged 49, NYCRIS adds that it is women who are called to the screening process early and who have in fact been detected through screening. They may have been called to the screening process early due to family history etc.
8. Uncategorised at QARC – this is due to insufficient information being available to categorise a case.
9. Unmatched at QARC – NYCRIS say the patient cannot be matched at QARC so may not have an NHS number etc. QARC say it is because of an absence of screening record within the region.
10. Unknown – no screening data.

It was decided that these categories would be best simplified for analysis and instead divided into just three categories:

1. Screen detected – this includes the screen detected, underage and overage categories.

2. Not screen detected – this includes, interval, non-attender, lapsed, uninvited, uncategorised at QARC and unmatched at QARC.
3. No information – this is cases from the unknown category where there is no screening related information.

Within the breast cancer cases there was a small number of stage 0 cases (n = 100). Stage 0, or carcinoma in situ, in breast cancer is often referred to as a pre-cancerous stage and in conjunction with the small sample number it was decided that these cases should be excluded from the dataset and analysis.

Prior to linking the datasets they were reviewed for problems and errors, specifically if there was any important missing information, or information that was incorrect. This was important as it ensured that the data received had all the relevant and required information, particularly in the case of the NYCRIS dataset which provided GP information for each case. Each GP practice that participates in the QOF scheme is given a code which is unique to that practice. It was through this code that the patient's information regarding cancer stage etc. was linked with the GP practice information regarding practice quality. Therefore, it was of great importance that any issues or unknown GP codes were identified in an attempt to reduce the number of practices that would be excluded from analysis.

Data from the practice profiles has already undergone a review by the PHO which meant that problems like missing data and clerical errors have already been addressed. Practice profile data is publically available and accessible to download from the practice profiles website as needed; however, this data is only available to download in large Excel spreadsheets which contain all the practice profile data. This became a problem as a large amount of time was spent excluding any unnecessary data, specifically fields which are not related to this research, such as, QOF indicators about asthma or mental health. The practice profiles are grouped by PCT, with each Excel file containing data for each practice

within that PCT. In total there were 23 PCTs and resulting Excel files, which were combined and converted from Excel to Stata.

While this data is freely available to access and download, the format in which it is downloaded was not workable for this research and does not lend itself to data manipulation. Also as identified above, the practice profiles contain a large amount of information and variables which were not required for this research and as a result the Eastern Region Public Health Observatory (ERPHO), who are the lead on the practice profiles, were contacted. Upon request for data from specific PCTs and practice profile indicators ERPHO were able to provide the requested data in a raw data file. This meant only the data required was included and the data was in a more workable format, specifically it was able to be manipulated and moved between software packages more easily.

In contrast the NYCRIS data presented a very different set of problems. The data had not been cleaned and prepared to the same extent as the practice profiles and required data cleaning to resolve the problems of missing data and errors within the dataset. Problems with the use of cancer registry data have been highlighted in previous research (Parkin and Bray, 2009, Pascoe *et al.*, 2008), specifically with regard to the issue of missing data.

The first problem was whether the data could be located from another source. For example, in the case of cancer stage if this was unknown then little could be done to find out this information but in comparison if a GP practice code was unknown but the GP address was within the data then the practice code could potentially be found.

In the case of missing data that could not be retrieved, for a variable such as cancer stage this data was kept within the dataset and the cancer stage labelled as unknown.

While the preference would be to know the cancer stage, equally having a record that the cancer stage has not been recorded or obtained provides information for comparison and analysis. It could be argued and interpreted that a lack of cancer stage is an example of poor practice quality, because perhaps certain diagnostic tests have not been conducted or delays in reports or test results has meant that a diagnosis has been delayed or simply that organisation issues have prevented a cancer stage from being properly recorded.

The GP practice code is of critical importance within the NYCRIS dataset, as this is the variable which was used to link the NYCRIS data to the data from the practice profiles and QOF. Therefore, where GP practice was unknown, that particular patient case could not be linked to the practice data and would therefore have to be excluded from analysis. There were 1,874 cases with no practice details and these were excluded from any analysis. However, there were an additional 1,437 cases which did not have a practice code but had other practice details, such as practice name, address and postcode.

In these latter cases, attempts were made to find out the GP practice code. In 427 of these cases the code had simply not been inputted and by visually checking the practice name and address that was listed against another case with the same practice name and address a code could be identified and inputted. This then left 1,010 cases without a GP practice code.

In hindsight the identification of these practice codes was a time consuming process, particularly as they only account for 2% of the dataset. The key reason for trying to find the GP practice codes is to retain as many practices as possible to maintain the sample size for analysis. Also identifying where problems and errors occur and how to deal with and overcome these can be used to inform future practice and research using these databases.

Even with excluded data, knowing the GP practice code means that a note can be made on the number of practices that had to be excluded from analysis and for what reasons and also whether there are any common characteristics, i.e. whether they are perhaps single-handed practices or located in very rural areas.

4. 5. Weaknesses and errors in the dataset

The most common errors were as follows:

Clerical errors – these were most commonly misspellings of practice names, address and/or postcodes. For example, a postcode may have been recorded as DL7 8DO, when in fact it is DL7 8DP. These could be difficult to identify, as ordering/sorting the data by practice postcode etc. did not always highlight these errors, therefore hand searching through missing or anomalous data was required, which takes time.

Other clerical problems – the use of generic names when either details are unknown or perhaps records are illegible. For example, where the real practice name is unknown at a stage of recording this information it may have been completed simply with 'the surgery', or various similar combinations, such as if the practice is on a road called 'front street' or 'front street practice'. This causes a particular problem when practices are within health centres and it becomes harder to differentiate and accurately identify the practice.

Health centres - health and medical centres are commonly occupied by more than one practice, each with their own practice code but sharing the same address. This caused two problems, firstly which practice name was recorded; and if the individual practices have their own names, which are those used for the APHO practice profiles or QOF tables, but secondly the health centre also having an overall name. In the NYCRIS database the health centre name may have been recorded instead of the GP practice name, for example, Trinity Riverside Practice and Dr S Chander are both located at the Flagg Court Medical Centre but

both of the former may be recorded as the latter. In cases where the address was identical for multiple practices it was not possible to assign a practice code and the cases had to be excluded.

Branch practices – select practices have more than one practice or site. In these cases there is only one GP practice code and only the address of the primary/main practice is used in the practice profiles and QOF. In the NYCRIS dataset however, the address of a secondary branch practice may have been recorded instead of the primary site address. This causes a problem if just the address has been recorded and the GP code is missing, as it is not initially evident that the practice is part of a branch/group. In these circumstances it is of particular importance to identify the GP code and unify the cancer cases together, as only one or two cases of cancer maybe recorded at each practice site but as a whole the practice has seen a higher number of cancer cases and can be retained in the dataset rather than excluded.

4. 6. Process used for identifying GP practice codes

In the process of preparing the data and trying to identify GP practice codes the following process for identifying missing GP practice codes was developed.

Stage 1

- The NHS has a practice code 'look-up' table (http://www.ic.nhs.uk/statistics-and-data-collections/supporting-information/audits-and-performance/the-quality-and-outcomes-framework/qof-2007/08/data-tables). This Excel database lists the details, practice code, address, postcode etc., of all practices registered to QOF during 2007/2008 (no updated version is available). In addition there is an older file from 2004/2005 which if no results are found in the 07/08 file then the same information can be checked in this older file to see if perhaps the practice did exist

and has moved (http://www.ic.nhs.uk/statistics-and-data-collections/supporting-information/audits-and-performance/the-quality-and-outcomes-framework/qof-2004/05/qof-2004-05-detailed-spreadsheets).

- Within the Excel file the find function can be used to search for the postcode.
    - What seems to work best when searching within this database is to search for the first half of the postcode and then go through the resulting options. This is because sometimes the search does not always recognise the postcode, despite it being in the database, and sometimes by viewing the other postcodes in that area errors are picked up earlier. For example, when searching for a postcode such as TS17 1AY, there may be a postcode which is TS17 3AY and on closer inspection the latter is actually the correct postcode.

Stage 2

- If using the postcode in a search is not successful then the next step is to check the postcode is correct.
    - Searching for other address details in the look up files, such as street or village names, as the postcode boundaries may have changed.
    - There are also alternative websites and search options available if the NHS practice look up table does not prove successful.
        - Try an online map website – using such a website enables you to see if a postcode matches up with other address details.
        - Try Royal Mail address finder

- Can input postcode to the finder and it will display the address for that postcode, which can be compared against the address that has been provided.
- Can input first line of address and see if any of the postcode options match up.

  - Once a postcode error has been found, then it is advisable to return to the practice code look up table and search again using the correct postcode or other address details to see if the practice can be identified.

Stage 3

- If practice code can still not be found the next step is to search for the practice in the NHS search tool (http://www.nhs.uk/servicedirectories/Pages/ServiceSearch.aspx?ServiceType=GP) .
  - Details of the practice, such as the postcode, can be used to search for GPs near a location.
  - In particular GPs which are a branch practice or part of a larger practice/medical group, can easily be identified using this tool. Once the practice has been found details about other premises are listed on the practice page.

Stage 4

- If no results are found from the NHS search then the next step is to use a generic internet search engine, such as Google.
  - Often this type of search will bring back directory websites (i.e. yell.com) and these can be used to confirm the existence of the practice and possibly

provide correct (i.e. if something has been spelt incorrectly) or additional details (i.e. phone number, GP's name).

- This type of search may bring up the practice's own website and this is worth checking if no errors have been found in case the practice is part of a wider group or has relocated more recently (i.e. post 2008).

Other options

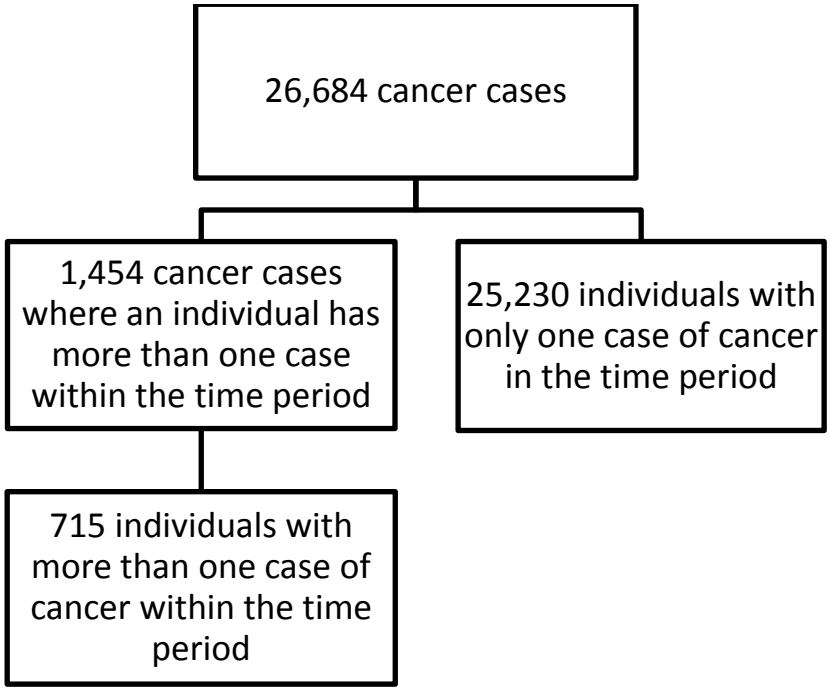
- Still no results then can try searching alternative details, for example, if postcode has been used try the practice name or street name. Equally searching for any additional details that have been found, such as telephone number, may yield a result.
- If you have a practice name or GP name you can try looking at the listed practices in a PCT on the APHO practice profile website (http://www.apho.org.uk/pracprof/). However, only the practice names and the GP codes are listed on this website and therefore a clear practice name is needed (i.e. something like 'the surgery' or 'the health centre' will not work).
- If after these steps a GP practice code can still not be found then it is likely that the GP is not registered with QOF and therefore does not have a practice code. These are then coded as 'NULL'

During data preparation it was discovered that the NYCRIS data is not laid out with each case (or line of data)as an individual, but rather each line of data is an individual case of a cancer tumour, therefore in individuals who experience multiple tumours or the development of other cancer tumours there are multiple cases/lines of data for these individuals. For example, there may be an ID number of '12345' and this may appear twice

within the dataset but one case can be for a stage 2 breast tumour from 2007 while the other is a stage 1 breast tumour from 2008.

1,454 multiple cases were found and within these there were 715 individuals/patients; this equates to just over 5% of the dataset consisting of multiple cases.

Figure 1. Incidences of multiple cancer cases in a patient.



In the majority of multiple cases there were just two cases, but there were instances within the dataset of patients having three or even four tumours recorded per patient within the time period (2006-2008). In 654 individuals the multiple cases are the same cancer, i.e. two cases of breast, but in 61 individuals the cases are for different cancers. As only breast and colorectal cancer are being focused upon in this research it is only known if an individual had both of these cancers. There is no indication in the NYCRIS dataset whether an individual developed another type of cancer within the time period (2006-2008) or whether they had already had a case of cancer or a resulting case after the time period.

The realisation of these multiple cases caused a problem as to whether they should be left in or whether their presence caused some kind of bias. There is a chance that some of the multiple cases are in fact errors and a tumour case has been recorded twice. The decision was made to keep the first recorded tumour and remove any subsequent cases

with a later date. Where there were multiple cases within the same year for an individual, the tumour with the most advanced stage was retained and the others removed and in cases where an individual had both cases of breast and colorectal cancer in the time period the first cases of both of these were retained and any secondary tumour cases removed.

Once these secondary cases were removed this presented a new problem for the dataset, as it reduced the number of cancer cases to below five for some practices, and as a result both datasets has to be searched again for small numbers and any practices with less than five cases were removed.

4. 7. Data combination

The data started in two separate datasets, data from NYCRIS in one dataset and in the other the data from the practice profiles and QOF. The two datasets were imported into Microsoft Access and combined using the GP code as the common data item.

Some alterations had to be made to the datasets to enable the combining of the data. Primarily there was a problem with the layout of data in the practice profile dataset where the data had to be rotated.

Once the data was combined then checks at random intervals were made to ensure that the data was still accurate and the merger of data had been successful. The data was moved back into Stata and divided into two working datasets based on cancer type (1; just breast cancer data and 2; just colorectal cancer data).

4. 8. Software

The decision was made to undertake analyses using the Stata (Version 11, StataCorp LP) statistical software package. There were two primary reasons for this choice. The first was the quantity of data that was being used and the level of manipulation that was required; other packages such as SPSS would have been inadequate for this task. Secondly, Stata was capable of the planned types of analysis, including a three level multi-level analysis. Alternative packages such as MLWin were an option but Stata is widely used within health statistics, support for this program was available within the University and it is also viewed as more user-friendly.

4. 9. Analysis

With all the data combined together and then separated into the two cancer specific datasets the analysis could begin. Outlined in this section is the plan of how the analysis was planned to be conducted and the resulting issues and changes which were made.

4. 9. 1. Variables

For the analysis there were a number of variables which related to different levels, these were patient variables, GP practice variables and PCT variables. A breakdown of the specific variables at each level is below:

Patient variables:

1. Age (2 groups; 18-64 or 65+)
2. Sex (2 groups; male or female)
3. Cancer type (2 groups; colorectal or breast)
4. Cancer stage (5 groups; 1, 2, 3, 4 or unknown)
5. GP code (nominal data, lots of groups)
6. Screen detected (3 groups; yes, no, no info. Only for breast)
7. Income domain quintile (ordinal 1, 2, 3, 4 or 5)

GP variables:

1. QOF scores
    a. Clinical domain (ordinal data, scores are in both percentage and actual score)
    b. Organisational domain (as above)
    c. Patient experience domain (as above)
    d. Additional services domain (as above)
    e. Total score (as above, combined from the previous 4 domains)
2. Specific points from the practice profiles.
    a. Indicator 275 – Cancer: review within 6 months of diagnosis
    b. 276 – Cancer: QOF prevalence (all ages)
    c. 277 – Exception rate for cancer indicators
    d. 336 – Percentage of patients age 65+ years
    e. 338 – Deprivation score (IMD 2007)
    f. 340 – IDAOPI (income deprivation affecting older people)
    g. 342 – Percentage satisfied with phone access
    h. 343 – Percentage able to see doctor within 2 days

i. 344 – Percentage able to book appointment >= 2 days ahead

j. 345 – Percentage satisfied with opening hours

k. 346 – Percentage able to see preferred GP

l. 641 – Percentage aged 75+ years

m. 642 – Percentage aged 85+ years

PCT variables:

Same as GP but grouped by Primary Care Trust (PCTs).

4. 9. 2. Preliminary analysis

There was a need at first to see how the data was distributed before more detailed analysis was conducted, this way it is easier to determine which analysis would be most appropriate, particularly as this is a large data set with a large number of variables.

The first stage was to look at the distribution of the key variables. The primary aim is to look at whether there is an association between cancer stage and GP practice quality, therefore cancer stage was plotted against primary quality measures, such as QOF total score and the individual QOF domains (organisational, clinical, patient experience and additional services). The secondary aim of this project is to look at other variables that may influence cancer stage or the practice quality (if cancer stage and practice quality are associated) therefore looking at variables such as cancer stage and age etc. is also beneficial to see if there is an association and whether it is statistically significant.

In addition to producing graphs as a visual representation of the distribution of the data, correlation matrixes were also conducted to see if there is any relationship between the variables.

4. 9. 3. Regression analysis

Once the distributions and correlations of the data were examined a regression analysis was carried out. Regression analysis was chosen due to the large number of potential explanatory variables; this form of analysis offers the best way to see how each of these interacts and influences the outcome. Again this was done separately for the two cancer types and initially all variables were included.

The primary aim of this research is to investigate the association between cancer stage at diagnosis and GP practice quality, therefore the outcome measure is the cancer stage. Within the dataset, cancer stage is a categorical variable and has five categories (stage 1, 2, 3, 4 and unknown). Regression analysis requires the outcome variable to only have two categories for comparative analysis, i.e. stage 1 v 2, stage 1 v 3 etc. A results base outcome regression was chosen as this form of analysis allows the selection of a base category for the remaining categories to be compared against. Due to the stage system used to classify the development and progression of cancer cases a number of previous studies have adopted the use of base outcome, or multinomial in Stata, regression for their analysis (Keating *et al.*, 2010, Tarlov *et al.*, 2009).

This worked well for this research as it separated and compared the various combinations of stages enabling a more in-depth look at how any potential associations may work.

It should be noted that the standard output in Stata for multinomial regression includes; coefficient, standard error, z, P>[z], and the 95% confidence interval range. The presentation of coefficients is not always preferable for interpretation and a change to Odds Ratios (OR) would be standard practice. However, Stata does not produce ORs for multinomial regression (`mlogit`) but produces Relative Risk Ratios (rrr) which have been

used in the outputs and results that follow. There has been debate about whether RRR are an equivelant of (or even the same as) Odds Ratios (Gutierrez, 2005), Rabe-Hesketh & Skrondal (2012) in their book (pg. 637) on categorical modeling in Stata demostrate that RRR in Stata and OR are comparable.

4. 9. 4. Multi-level model

Using base outcome regression, analysis is however unable to separate and specify the potential influence that GP practice and even living within a particular PCT can have. It was decided that using multi-level modelling would help to identify specifically how much of the variance between cancer stages could be attributed to the GP practice and PCT.

Within the dataset there are 3 levels of data:

1. Patient/individual cases
2. Practice – combination of patient data within a practice (identified by practice code)
3. PCT – combination of practices within a PCT (identified by PCT code)

The primary question is to see if there is a potential link between practice quality and stage of cancer at diagnosis, which requires the two levels of patient and practice level to be analysed. PCT is important to put in as a third level because of the influence PCTs have upon a practice regarding commissioning and finance. How a PCT divides out funding etc. and also what schemes and interventions they get involved with influences the practice and therefore should be included.

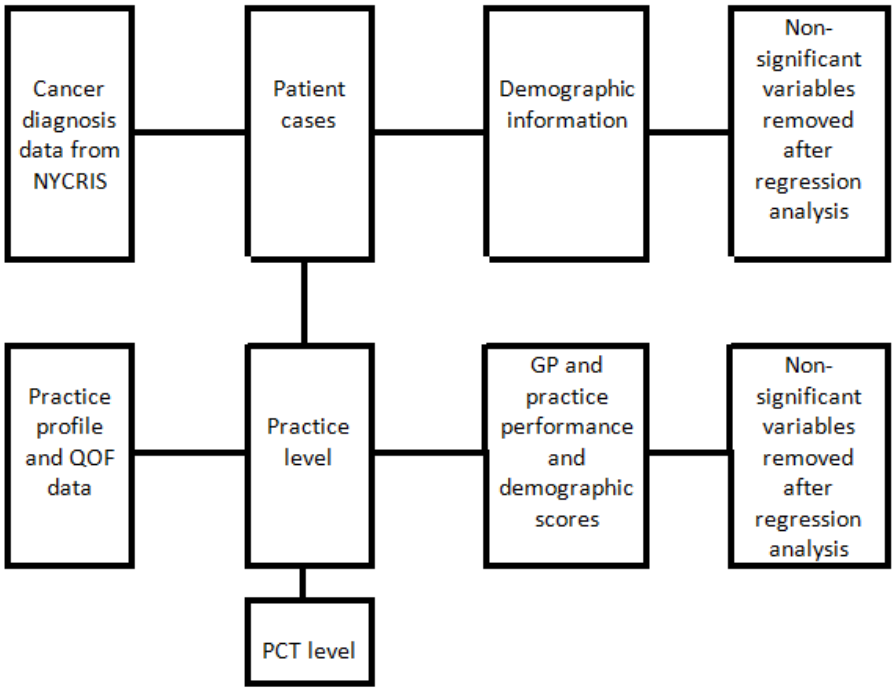
Multi-level modelling is regularly used as a method of analysis where it is thought that higher, level processes are influencing processes at a lower level. In the case of this research higher level processes are the GP practice and PCT level which are providing the

health care to diagnose and treat patients, which are the lower level. While the base outcome regression is able to identify variables which contribute towards cancer stage at diagnosis, conducting a multi-level analysis provides a more specific and clear look at how much GP practice or PCT variables are contributing to cancer stage (Luke, 2004).

Again a base outcome approach was used, while this was in part due to the same analysis limitations as before the regression analysis also showed that not all cancer stage comparisons provided a significant result. A similar method has been used in previous research which examined factors which affected the stage of prostate cancer at diagnosis (Zhou *et al.*, 2008).

To begin with all variables were included in the analyses but this was refined and the variables reduced based on the findings from the first regression analyses and the outcomes of the initial multi-level models. This was done to get a clearer indication of the impact of significant variables on the outcome. For example, many initial models were non-significant due to the majority of variables being non-significant and therefore influencing the overall significance of the model.

Figure 2. Outline of multi-level model



4. 10. Additional analysis

4. 10. 1. Deciles

Looking at the distribution of QOF data it was found to be positively skewed, see figures 3 & 4. This was to be expected, since it is a common criticism of QOF and reflects the fact that practices are financially incentivised to achieve high scores. However, looking at the graphs, there are a number of outlier practices which do not achieve the maximum number of points and in fact achieve less than the average total score.

Figure 3. QOF total score and patient colorectal cancer stage.

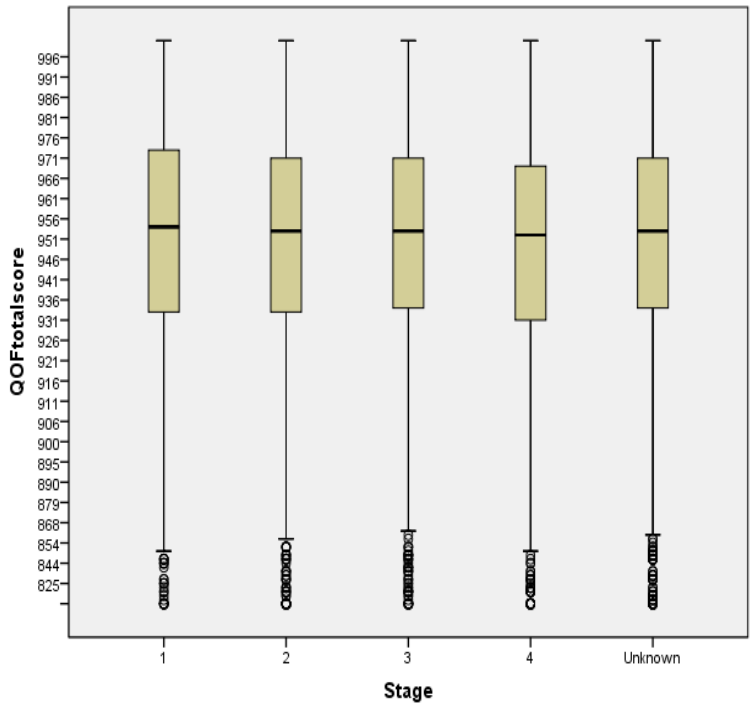
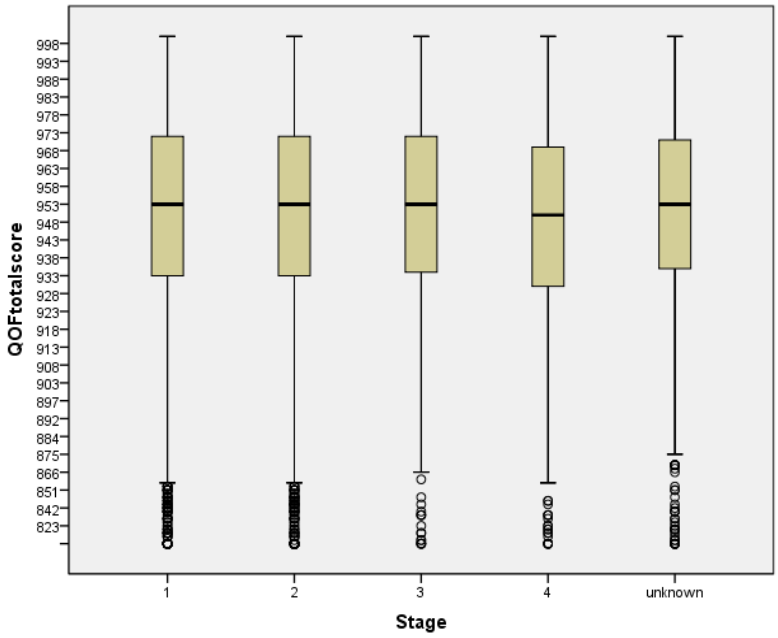


Figure 4. QOF total score and patient breast cancer stage.



It was discussed that this positive skew could impact upon the analysis and the observation of the outliers led to the decision to split the data into deciles. This way a comparison could be made in analysis of the top performing 10% of practices and the bottom 10% of practices, basically comparing what has been assessed as the best and worst practices in QOF. The aim of doing this is to try and account for the positive skew and reduce the effect of having many of the practices clustered together. Previous research has used this approach of comparing top and bottom percentage groups in a range of cancer research from comparing top and bottom socio-economic status quintiles (Smith *et al.*, 2012, Linseisen *et al.*, 2011, Møller *et al.*, 2012) to specific outcome measure variables such as the top and bottom quintiles of dietary fibre scores (Cui *et al.*, 2011, Fung *et al.*, 2010, Tworoger *et al.*, 2011, Wilson *et al.*, 2010).

This division into deciles was initially done based upon the QOF total score. However, the QOF total score is made up of four domains, clinical, organisational, patient experience, and organisational. Following some of the results from initial analyses the decision was

made to repeat this process of separating the data into deciles with each of the four QOF domains, as for example, a GP practice may perform well and score highly in three of the domains but score poorly in one domain and bring the practice's total score down into the bottom decile. Equally a practice may perform poorly across the majority of the domains but achieve the maximum score in the other domain(s) and that may bring the practice into the top decile.

The decile ranking based on each individual QOF domain was therefore calculated for both the breast and colorectal datasets and the regression analysis was repeated using the decile ranking of each of the four QOF domains and the top and bottom deciles were compared.

4. 10. 2. Screening effects

In the case of the breast cancer dataset there was concern after the analysis that there could be a screening effect within practices. GP and practice factors were found to influence breast cancer stage at diagnosis, and while screen detected cases were removed, there is an argument that there could be a wider reaching effect.

Of primary concern is the potential for wide variation between GP practices in breast cancer screening uptake, which could affect the analysis. For example, in a GP practice where the screening uptake is 20% and another where the uptake is 80% this variation in screening uptake would result in the practice with 80% potentially having a higher proportion of less advanced staged cancer cases. Previous research has shown that screen detected cases have a less advabnced stage at diagnosis comapred to sympotmatic cases.

This concept is similar to the Hawthorne Effect, which was first observed in industrial research but has since been observed and applied to a number of clinical research and

practice settings (Fernald *et al.*, 2012, Efraimsson *et al.*, 2008, Pascoe, 1983, McCarney *et al.*, 2007). The Hawthorne Effect suggests that an intervention, regardless of what it is, will have a positive effect. In this case a GP and/or practice that demonstrates good screening behaviour could potentially have a positive effect across the practice, specifically less advanced stage of breast cancer at diagnosis. However, it has been shown that there is variation between practices in breast screening uptake and screening referral behaviours.

Chapter 3 highlights the influence that a GP can have on cancer referrals and reccomendations, such as precieved barriers to diagnoistic tests (Daly and Colins, 2007) and interpretation of symptoms (Carney *et al.,* 1993). Previous research has also shown that variations in deprivation and ethnicity within the patient population can also affect screening uptake numbers. Bell *et al.,* (2010) and Jack *et al.,* (2014) both found that ethnic minority groups had a lower uptake of breast screening compared to white British females, therefore in certain geographic regions where practices have high numbers of ethnic minority patients this will affect the breast screening uptake rate of the practice in general. In addition, Gatrell *et al.,* (1998) found low breast screening uptake in practices located in deprivied areas, while Carney *et al.,* (2013) found that patient income did not affect screening uptake, but past screening behaviour was found to have a signficant effect.

With these concerns in mind another version of the breast cancer dataset was prepared with all cases of patients aged between 50-70 (the age range for the national screening programme at this time) removed. From the data that remained this has to be checked for small numbers of cases within a practice, to ensure that the ethical guidelines and stipulations are met.

The regression analyses and multi-level analysis were then repeated on this dataset to account for any confounding due to practice variation in screening uptake and potential screening effect, but also served to see if repeated analysis influenced the results.

4. 11. Dichotomised and unknown stage

In the colorectal dataset there were a high percentage of cases with unknown stage, 25.9%. How to treat this stage status needed consideration as it could simply be that patients have died etc. which has resulted in a stage not being recorded but equally it could be due to organisational and clinical issues of quality. Previous research has identified that patients with an unknown cancer stage generally have poorer outcomes, greater risk of mortality and reduced access to treatment (Merrill *et al.*, 2011, Ciccolallo *et al.*, 2005, Comber *et al.*, 2005). As a result unknown stage cases have been treated as and grouped with more advanced stage cancers (Virnig *et al.*, 2009).

Analysis was repeated with and without unknown stage cancer cases to determine how this modified the results.

Additional analysis was also conducted with the cancer stages dichotomised, into less advanced (stage 1 & 2) and more advanced (3, 4 & unknown) cancer stage at diagnosis. The decision for this was to try and account for the uneven distribution across the cancer stages, specifically in breast cancer where the majority of cases are diagnosed at stage 1 and 2; by grouping the later stages together it increased the sample size for that group. Dichotomising cancer stage is a common practice within cancer research (Lindstrom *et al.*, 2009, Haikel *et al.*, 2011) and specifically within breast (Van den Eynden *et al.*, 2005) and colorectal (Lee *et al.*, 2000).

5. Chapter 5: Results

This chapter will outline the findings of the analysis conducted for this study.

The primary aim of this study was to see if there was any evidence of GP quality influencing a patient's cancer stage at diagnosis in breast and colorectal cancer cases.

Data relating to GP quality came from the GP practice profiles that are constructed by the Eastern region public health observatory and additional GP data had come from the NHS information service regarding QOF scores. Cancer and patient data came from NYCRIS, further details of the data acquired for this project are outlined in the methods chapter.

As breast and colorectal cancer differ significantly in the way they present and their symptomology, screening programmes, how they are identified, diagnostic methods etc., it was decided that they should be analysed separately. So the dataset was divided into breast and colorectal cancer and the range of analyses was carried out on both cancer datasets separately.

A range of analyses were used. Initially descriptive and correlation matrixes were used to understand how the data was distributed. From this the decision was made to also separate the data into deciles, in an attempt to account for the positive bias and skew of the QOF data.

A base outcome regression analysis was used, this was most appropriate due to the categorical nature of the data and dependent variable (cancer stage at diagnosis) and then a multi-level regression analysis was then conducted. Once these had been carried out the findings led to the addition of further regression analyses and a trend analysis to investigate certain results more closely.

With regards to the primary research aim, the multi-level analysis showed that the GP practice a patient attends does have an influence upon breast cancer stage at diagnosis, in some cases accounting for over 25% of the variance. The regression analyses of the breast cancer data did show a relationship between QOF and cancer stage at diagnosis and some specific practice variables appear to have an impact upon cancer stage at diagnosis, particularly whether a patient is able to see their preferred GP. Patient variables, specifically age and level of income (a measure of deprivation), were found to produce a significant influence upon cancer stage.

For colorectal cancer the multi-level analysis did not produce significant results, in fact it appears that a patient's GP practice does not account for any of the variance in colorectal cancer stage at diagnosis. Neither was the PCT in which a practice is located found to have a significant influence upon patient cancer stage. However, in the regression analyses patient variables, specifically age and a patient income level, were found to have a significant affect upon cancer stage at diagnosis. The QOF domains and total score were not found to have a significant affect; however, specific practice variables such as those related to elderly patients (those over 65) and a patient's ability to see a doctor within two days were found to have a significant effect on cancer stage at diagnosis.

As previously stated the original dataset of breast and colorectal cancer cases received from NYCRIS contained 28,964 individual cases. After data cleaning the total number of cases within the NYCRIS dataset was n = 25,216 (n = 3,728 cases were excluded, see chapter 4 for further details). These two cancers were separated into individual datasets, breast cancer had 13,610 cases (which was 54% of the original dataset) and colorectal 11,606 cases (46% of the original dataset). The breakdown of each individual dataset and analysis will now be reported in detail, starting with the colorectal cancer results first, followed by the breast cancer results.

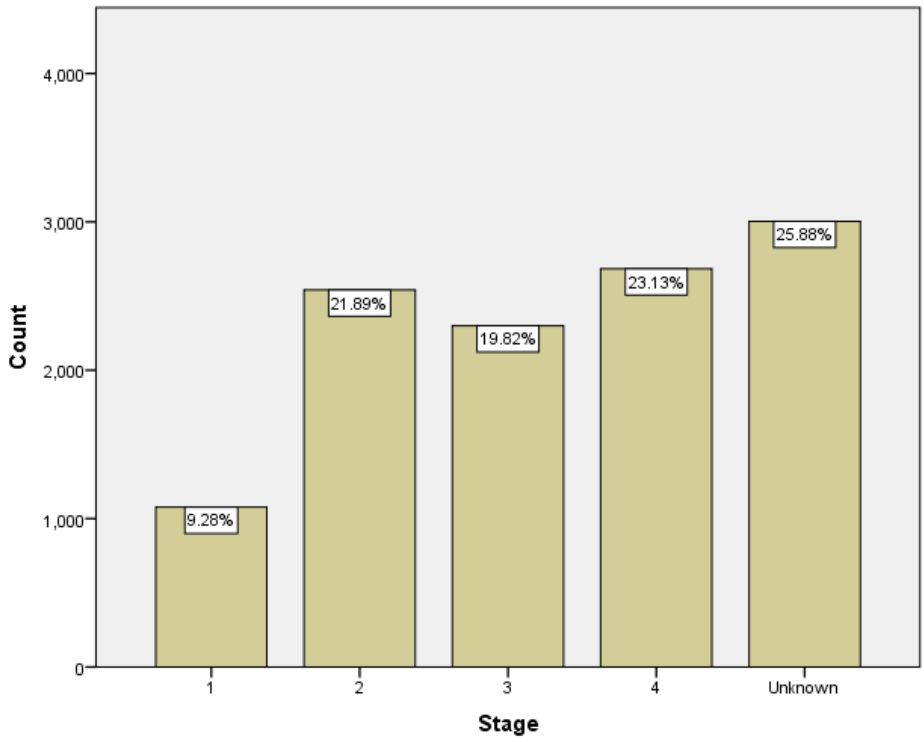
5. 1. Colorectal cancer

5. 1. 1. Descriptive and distribution analysis

Initially a basic breakdown of each of the cancer types was conducted and the breakdown for colorectal cancer was as follows.

Cancer stage ranged from 1-4 and unknown (further details can be found in Chapter 4; methods). In the colorectal dataset 25.9% of the dataset had an unknown stage recorded and stage 3 and 4 cases, which are the more advanced stages, constituted 42.9% of the dataset (figure 5).

Figure 5. Distribution of colorectal cancer stage.



National data for patient recorded colorectal cancer stage in England is comparable with; stage 1 – 8.7%, stage 2 – 24.2%, stage 3 – 23.6%, stage 4 – 34.3%, and unknown stage 34.3% (Abdel-Rahman *et al.*, 2009).

Within the patient information that was provided by NYCRIS, along with cancer stage, the key variables were age, sex and income domain (which was divided into quintiles, with 1 being the least deprivied and 5 the most deprivied) . Age had been categorised into working age (18-64) and retirement age (65+) and within the colorectal dataset there was a greater number of cases from patients of retirement age (73.3%) compared to working age (26.7%).

Table 2. Cross tabulation of colorectal cancer stage and patient age group.

Stage	**Age**		**Total**
	18-64	**65+**	
1	279 (25.9%)	798 (74.1%)	1077
2	576 (22.7%)	1965 (77.3%)	2541
3	643 (28%)	1657 (72%)	2300
4	786 (29.3%)	1898 (70.7%)	2684
Unknown	820 (27.3%)	2184 (72.7%)	3004
Total	3104 (26.7%)	8502 (73.3%)	11606

Figure 6. Distribution of colorectal cancer stage at diagnosis by age.

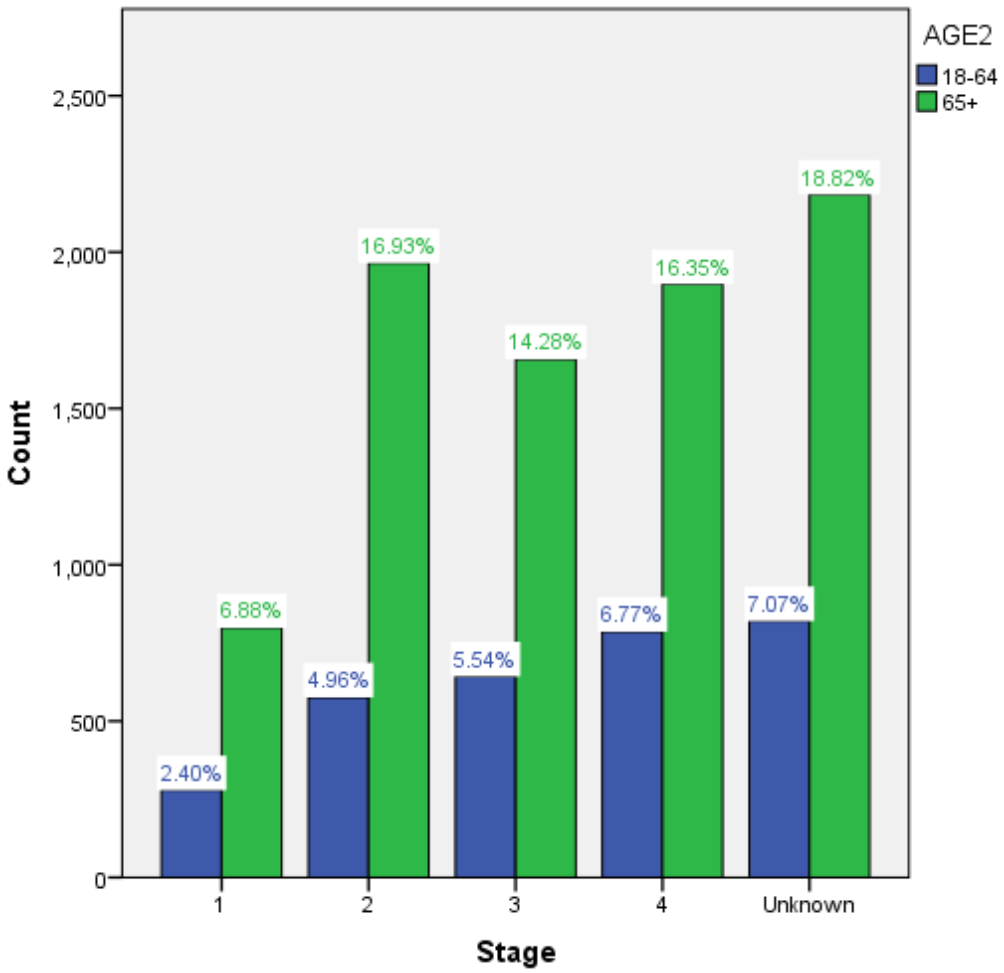


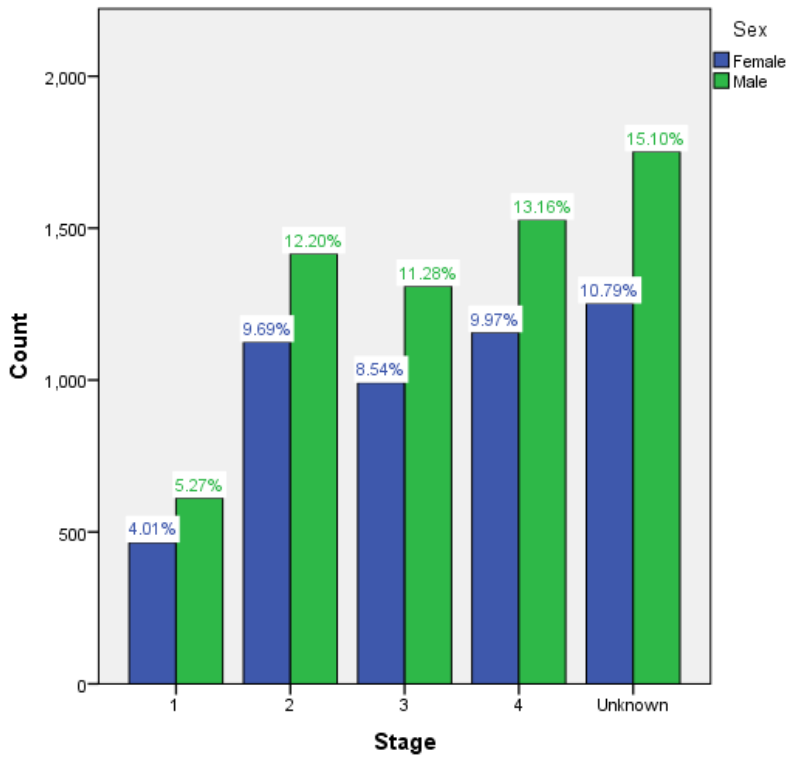
Table 2 and Figure 6 show this distribution, that more cases were found in patients of retirement age, and a chi-square test showed that there was a significant relationship between a patient's age and their cancer stage, X^2 (8) = 34.55, p < .0001.

The sex distribution of cases was reasonably even, with 43% of cases being female and 57% male patients. For Table 3 it can be observed that for each individual stage the distribution between the two sexes follows a similar pattern, when a chi-square test was conducted it found the relationship between cancer stage and sex to be non-significant X^2 (4) = 3.86, p = .426. National trends of colorectal cancer cases by patient sex showed that in 2010, 56% of new colorectal cancer cases were male and 44% female (Iyen-Omofoman *et al.*, 2011).

Table 3. Cross tabulation of colorectal cancer stage and patients' sex.

Stage	Sex		Total
	Female	Male	
1	465 (43.2%)	612 (56.8%)	1077
2	1125 (44.3%)	1416 (55.7%)	2541
3	991 (43.1%)	1309 (56.9%)	2300
4	1157 (43.1%)	1527 (56.9%)	2684
Unknown	1252 (41.7%)	1752 (58.3%)	3004
Total	4990 (43%)	6616 (57%)	11606

Figure 7. Distribution of colorectal cancer cases based on the sex of the patient.

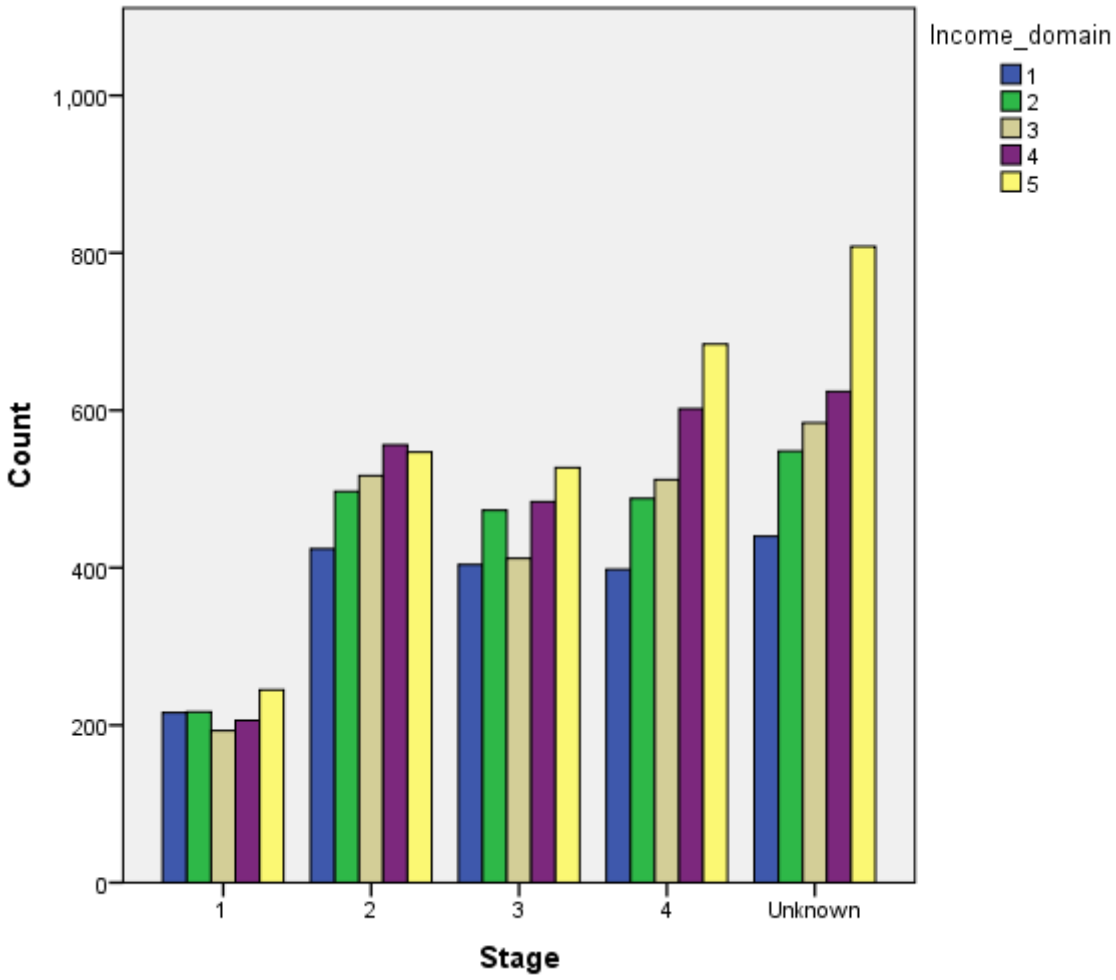


Income domain is separated into quintiles (range is therefore 1-5) with five representing the most deprived and one the least deprived. Distribution of stage across the five income domains ranges with the lowest percentage being the least deprived quintile (1 = 16.2%) and the most deprived quintile having the highest percentage of colorectal cancer cases (5 = 24.2%), the other quintiles range between these two.

Table 4. Cross tabulation of colorectal cancer stage and patient income domain.

Stage	Income domain					Total
	1	2	3	4	5	
1	216 (20%)	217 (20.2%)	193 (17.9%)	206 (19.1%)	245 (22.8%)	1077
2	424 (16.7%)	497 (19.6%)	517 (20.4%)	556 (21.8%)	547 (21.5%)	2541
3	404 (17.6%)	473 (20.6%)	412 (17.9%)	484 (21%)	527 (22.9%)	2300
4	398 (14.8%)	488 (18.2%)	512 (19.1%)	602 (22.4%)	684 (25.5%)	2684
Unknown	440 (14.7%)	548 (18.2%)	584 (19.4%)	624 (20.7%)	808 (27%)	3004
Total	1882 (16.2%)	2223 (19.2%)	2218 (19.1%)	2472 (21.3%)	2811 (24.2%)	11606

Figure 8. Distribution of colorectal cancer cases across the different stages, grouped by patient income domain.



The distributions in the above Table 4 and Figure 8 between cancer stage in colorectal cancer and patient income domain were found to be significant, X^2 (16) = 56.70, p<.0001.

5. 1. 2. QOF data and distributions

The QOF data used was from the 2009/2010 data, the most recent available at the time of the start of this project. QOF is annually reviewed and changes made, such as the retirement or addition of indicators. In 2009/2010 QOF was divided into four domains and these culminate into a total score. The maximum scores for each domain and the maximum total score were:

Clinical domain = 697

Organisational domain = 167.5 (rounded up to 168)

Patient experience domain = 91.5 (rounded up to 92)

Additional services domain = 44

Total score = 1,000 *(Note: while the organisational and patient experience domains are rounded up the maximum total score attainable in QOF remains at 1000, instead of 1001)*

The distribution of the QOF data is important as it is well documented that there is a positive skew within QOF, with the majority of practices scoring either maximum points or near maximum. Within this dataset there were 792 GP practices, Table 5 below shows a breakdown of the maximum and minimum scores for each of the domains and total score.

Table 5. Summary statistics for each of the QOF domains and QOF total score.

	Minimum	Maximum	Standard deviation	Mean	National average (Department of Health, 2002)
Clinical domain	486	697	20.63	679.89	668.2
Organisational domain	102	168	6.56	164.14	161.4
Patient experience domain	30	92	17.50	62.94	65.4
Additional services domain	29	44	1.78	42.93	42.0
Total score	722	1000	32.06	949.54	936.9

The box plots that follow show that there were a number of outlier practices which score much lower than the mean or even the standard deviation.

Figure 9. Distribution of QOF total scores against colorectal cancer stage.

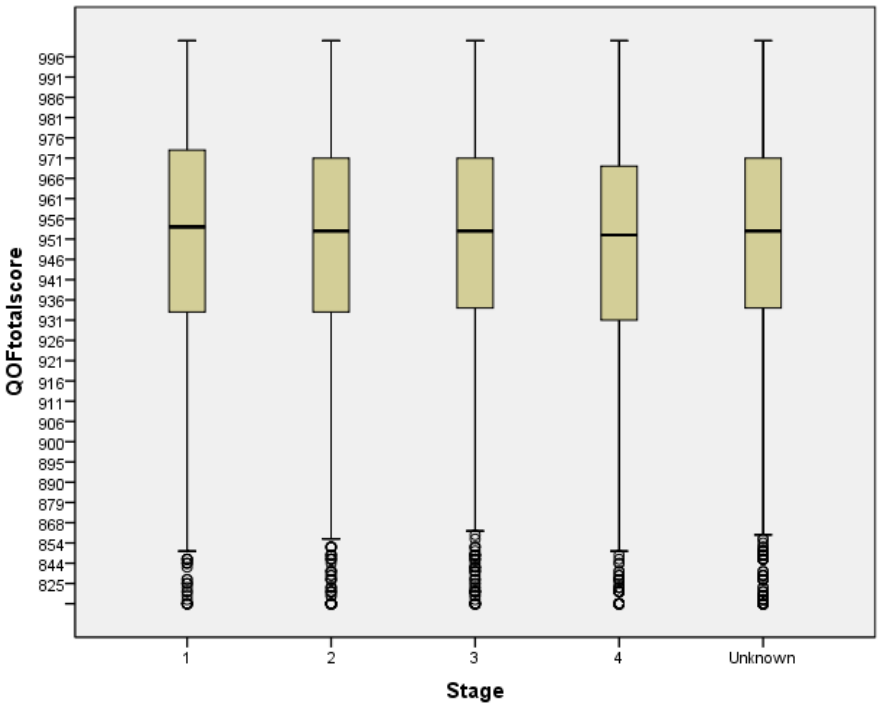


Figure 10. Distribution of QOF clinical domain scores against colorectal cancer stage.

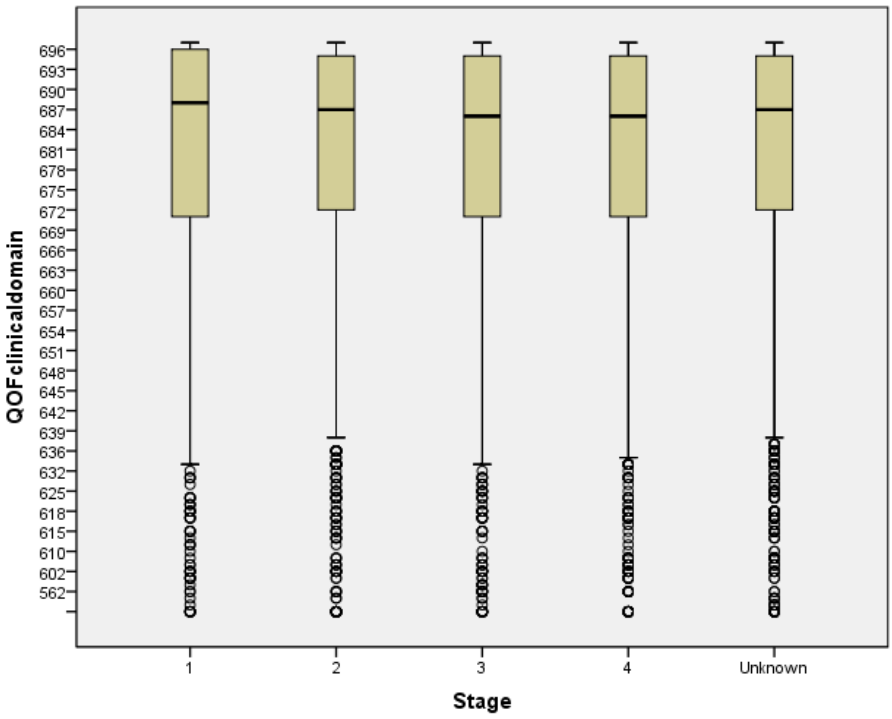


Figure 11. Distribution of QOF organisational domain scores against colorectal cancer stage.

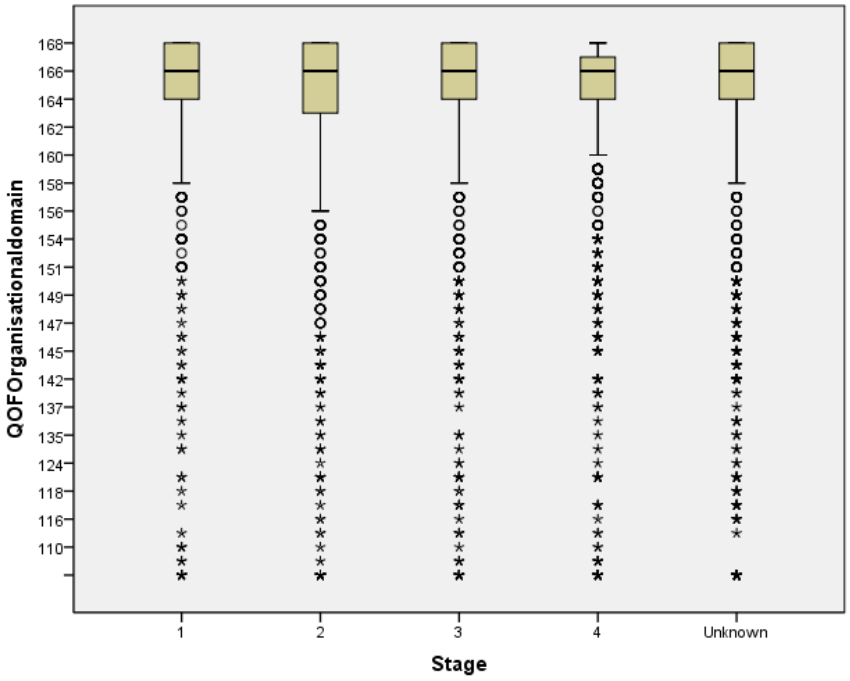
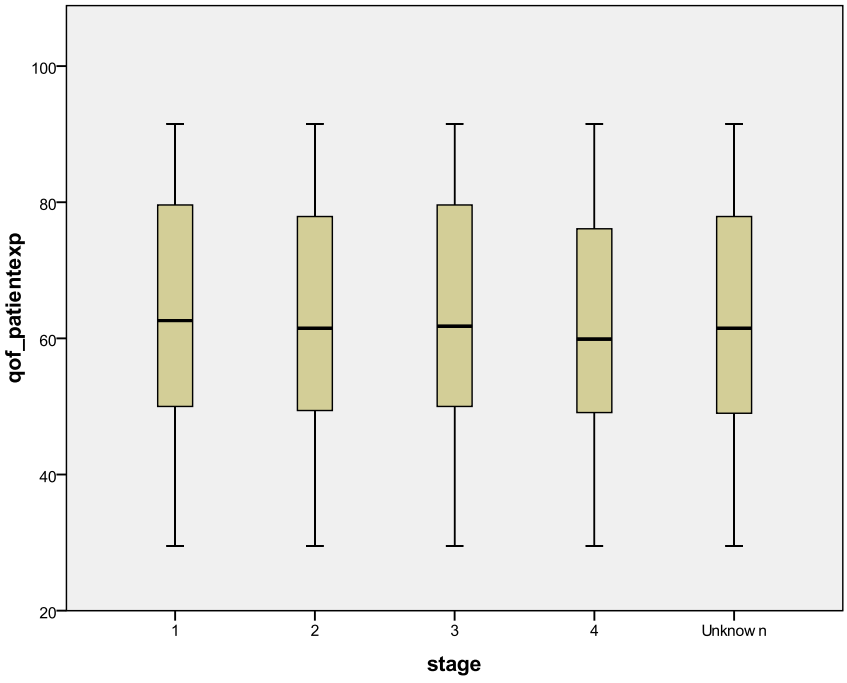
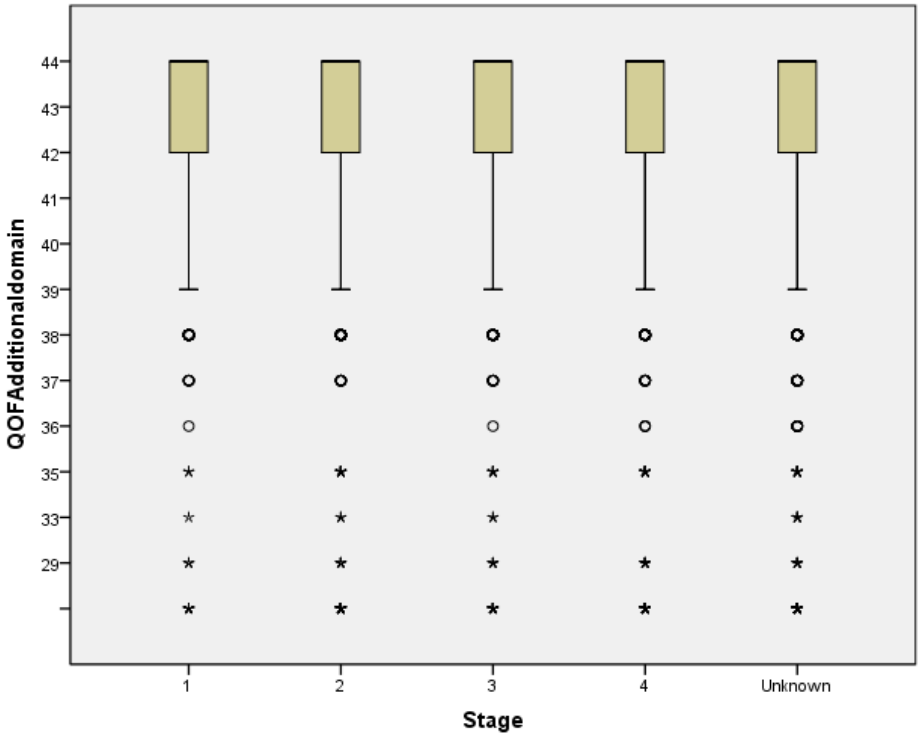


Figure 12. Distribution of QOF patient experience domain scores against colorectal cancer stage.



The patient experience domain was the only one of the domains which did not produce any outliers.

Figure 13. Distribution of QOF additional services domain scores against colorectal cancer stage.



5. 1. 2. 1. Deciles

From looking at the distribution of scores across the domains and the total QOF score from the figures (9-13) and table (5), as expected there was a bias and the majority of practices were scoring the maximum or near maximum points available. However, there were a number of practices which were outliers and were not scoring as high as the majority of practices, this observation prompted the decision to additionally separate the data into deciles so that the outcome of the top 10% and bottom 10% could be compared; effectively what could be termed as the best 10% of practices and the worst 10% of practices (for more details see chapter 4; methods).

5. 1. 3. Correlation matrixes

All colorectal cancer variables were put into a correlation matrix to investigate and establish whether there were already any existing correlations between the variables, see appendix 2; table 16.

It was expected that certain variables would show a significant interaction as they are related or are components of each other. For example, the QOF total score is the sum of the four individual QOF domains (clinical, organisation, patient experience and additional services). Equally patient income domain is widely used in larger measures of deprivation, such as the practice deprivation score found in the practice profiles, therefore a correlation between these two variables would be expected.

This was shown to be the case. The QOF total score and patient experience domain correlated with all the individual specific variables which make up the QOF domains. The clinical domain correlated significantly with all QOF variables except patient's ability to see their preferred GP. In the organisational domain the exception rating variable was the only non-significant QOF variable and for the additional services domain the exception rate, IDAOPI, patient ability to book an appointment and patient ability to see their preferred GP were all non-significant.

Patient income domain also correlated with the practice variables associated with deprivation (practice deprivation and IDAOPI [Income Domain Affecting Older People Index]). Specifically these were all positive correlations, so as patient deprivation increases so does practice deprivation and all are to the significance level of $p = 0.05$.

There was a well-recognised correlation between the QOF total score and the variables associated with deprivation, it was a negative correlation so as deprivation increased the QOF total score decreased ($p < 0.05$).

The only other significant correlation was between the cancer stage at diagnosis and patient income domain ($p < 0.05$), it was a positive correlation, so as income domain increases and therefore deprivation increases so does the cancer stage.

5. 1. 4. Regression analysis

5. 1. 4. 1. All colorectal data

5. 1. 4. 1. 1. Patient variables

Of the patient variables only age and patient income domain were found to produce any significant results.

Age produced a significant result between stage 4 versus 1, this was a negative coefficient which indicates that patients of working age, compared to those of retirement age, have a greater likelihood of being diagnosed at a more advanced stage.

Patient income domain between stage 1 and stage 4 and unknown stage produced significant positive coefficients, so an increase in patient income domain and therefore their level of deprivation means patients are more likely to be diagnosed with a more advanced cancer stage or an unknown stage at diagnosis. This relationship remained significant between stage 1 versus stage 4 when the analysis was run with just the top and bottom deciles.

Patient sex was not found to have a significant affect upon patient cancer stage at diagnosis.

5. 1. 4. 1. 2. QOF domains and total

No significant relationships or findings were observed between the QOF domain or total scores and the breast cancer stage at diagnosis. This did not change when the analysis was run with just the top and bottom deciles.

5. 1. 4. 1. 3. Practice variables and GP/PCT codes

There was a significant association found between stage 1 and unknown stage colorectal cancer with whether a patient was able to see a doctor within two days, this is a specific indicator from the patient experience domain of QOF.

All other specific practice variables were found to be not significant, these were; cancer reviewing within six months, cancer prevalence, exception rate for cancer indicators, percentage of patients aged 65+, deprivation score for the practice, IDAOPI, percentage satisfied with phone access, percentage able to book appointment >= 2 days ahead, percentage satisfied with opening hours, percentage able to see preferred GP, percentage aged 75+, and percentage aged 85+.

Table 6. Base outcome output for colorectal data, with stage 1 as the base outcome.

Full output is available in appendix (4).

Multinomial logistic regression Number of obs = 11491
LR chi2(84) = 145.84
Prob > chi2 = 0.0000
Log likelihood = -17880.668 Pseudo R2 = 0.0041

Stage	Variable	Relative Risk Ratio (rrr)	Standard error	z	P>[z]	[95% confidence interval]
1 v 2	Income domain	1.065	.0318	2.11	0.035	1.005 1.129
1 v 4	Age	.8313	.0677	-2.27	0.023	.7087 .9750
	Income domain	1.121	.0332	3.85	0.000	1.058 1.188
1 v Unknown	Income domain	1.137	.0332	4.40	0.000	1.074 1.204
	Ability to see Dr within two days	.2197	.1361	-2.45	.014	.0652 .7399

5. 1. 4. 2. Top and bottom deciles of the colorectal dataset

When the regression analysis was repeated with just the top and bottom 10% of practices, based on the QOF total score, there was only one significant result. This was between stage 1 and stage 4 and patient income domain, it was a positive coefficient which meant as patient income domain increased (patient income was lower) their likelihood of have a more advanced stage of colorectal cancer increased (table 7). All previous significant results became non-significant.

Table 7. Base outcome output, with just the top and bottom deciles of the QOF total score, base outcome is stage 1.

Full output is available in appendix (5).

Multinomial logistic regression Number of obs = 2340
LR chi2(84) = 75.41
Prob > chi2 = 0.7374
Log likelihood = -3643.9045 Pseudo R2 = 0.0102

Stage	Variable	Relative Risk Ratio (rrr)	Standard error	z	P>[z]	[95% confidence interval]
1 v 4	Income domain	1.139	.0758	1.96	0.050	.9997 1.298

The regression analysis was repeated with the colorectal dataset being separated into deciles based on each of the four QOF domains individually. Therefore, the regression analysis was repeated with data from the top and bottom deciles of the QOF clinical domain, then repeated with the data from the top and bottom deciles based on the QOF organisational domain and so on. The following variables were all found to be non-significant across the four analyses; patient sex, the QOF domain and total scores, cancer reviewing within six months, cancer prevalence, exception rate for cancer indicators, deprivation score for the practice, IDAOPI, percentage able to book appointment >= 2 days ahead, percentage satisfied with opening hours, percentage able to see preferred GP, percentage aged 75+, and percentage aged 85+.

The significant results are as follows:

5. 1. 4. 2. 1. Clinical domain

Age was found to be significant between stage 1 versus stage 4 and unknown, but both with RRR of <1 which indicates that as patients get older (those of retirement age) they are

more likely to be diagnoised with a less advanced stage of coloretcal cancer (RRR of .695 for stage 4 and .746 for unknown stage).

The specific practice variable of patient satisfaction with phone access was also found to be significant between stage 1 and stage 4 and unknown, with RRR of 3.37 and 3.4 respectively.

Patient income domain quintile produced a significant result between stage 1 and stage unknown, with a RRR of 1.16.

5. 1. 4. 2. 2. Organisational domain

Patient income domain was found to be a significant result between stage 1 and stage 4 (RRR = 1.121) and unknown (RRR = 1.155), the RRR was >1 which suggests that as income domain increases (and therefore the patient's deprivation), the likelihood of a more advanced or unknown stage being recorded increases.

The QOF domain of additional services was found to be significant between stage 1 versus stage 2 (RRR = 1.246) and stage unknown (RRR = 1.270), both with RRR >1 which suggests that as the score on the additional services domain increases so does the likelihood of a more advanced or unknown stage of colorectal cancer.

Patient age was significant between stage 1 and stage 3, with a RRR of .758 implying that younger patients are more likley to be diagnoised with a more advanced stage of colorectal cancer. The practice variable of the proportion of patients over the age of 85 was significant but with a low RRR (>.0001).

The specific practice variable of patient satisfaction with phone access was also found to be significant between stage 1 and stage 4 and stage unknown, with RRR of 3.109 and 2.961 respectively .

5. 1. 4. 2. 3. Patient experience domain

Between stage 1 against stage 2 (RRR = 1.233), 4 (RRR = 1.169) and unknown (RRR = 1.195) patient income domain was a significant result, all with RRR >1 implying that as patient income domain quintile and therefore level of deprivation, increases so does the likelihood of the cancer stage being more advanced or unknown.

The specific practice variable of proportion of elderly patients (65+) within the practice was found to be significant between stage 1 versus 2 and 3, with RRR of 538 and 213 respectively these are exceptionally greater than stage1 and implies that as the proportion of elderly patients increases so does the likelihood so the cancer stage being stage 2 or 3 compared with stage 1.

Other significant practice variables were between stage 1 and stage 4 whether a cancer review was conducted within six months, a RRR of 6.329, and between stage 1 and stage unknown a patient's ability to see their preferred GP had a RRR of .107.

5. 1. 4. 2. 4. Additional services domain

Patient income domain was found to be a significant result between stage 1 and stage 4 (RRR = 1.108) and unknown (RRR = 1.117), the RRR was >1 which suggests that as income domain increases (and therefore the patient deprivation), the likelihood of a more advanced or unknown stage being recorded increases.

The specific practice variable of patient satisfaction with phone access was also found to be significant between stage 1 and stage 3, with a RRR of 2.31 this suggests as satisfaction with phone access increases so does the likelihood of a patient being diagnosed with a more advanced stage of colorectal cancer.

Age was also found to be significant between stage 1 and stage 4, with a RRR of .808, and between stage 1 and unknown stage the specific practice variable of patient's ability to see their doctor within two days was also significant (RRR = .154).

There is the concern that, due to the large number of variables in this analysis a type one error may occur and significant results may be found by chance rather than because they are statistically significant. For this data there are a few considerations as each variable differed in their distribution; some variables have normal and expected distributions, while others are much more varied. For multinomial regression in Stata it is recommended (Institute for digital research and education, no date) to refer to the 'prob > chi2', a measure of 'good-fit', and 'pseudo R2', which is McFadden's pseudo R-adjusted, and these were all <0.05 with the exception of the regression analysis for colorectal cancer with just the top and bottom decile included in the analysis.

A marginal effects analysis was additionally conducted to further investigate, and this found that there were significant results for a patient's income domain, percentage of elderly patients within a practice, and patient satisfaction with opening hours of the practice, this was in line with the signifcant results found prior to the adjustment.

5. 1. 5. Multi-level model

From the regression analysis there were only a small number of significant findings and all but one of these were from patient level variables, therefore it was unsurprising when the multi-level analysis for colorectal cancer did not produce any significant results to suggest a relationship between GP practice or PCT and patient cancer stage at diagnosis. Specifically from the analysis between each of the cancer stages variance is less than 0.01%.

The analysis was repeated with just the top and bottom deciles to see if this would draw out any effect but again the variance attributed to GP practice and PCT does not exceed 0.01%.

5. 1. 6. Dichotomised stage

It was recommended to combine colorectal cancer stages together as an additional analysis. For the previous analyses there had been five cancer stage categories for both breast and colorectal cancer, stage 1-4 and unknown stage. By combining stage 1 and 2, the less advanced stages, together and combining stage 3, 4 and unknown, the more advanced stages, it provided the opportunity for a more direct comparison of the more advanced cancer cases against the less advanced cases (a more detailed explanation is provided in chapter 4; methods).

5. 1. 6. 1. Colorectal cancer stage 1 & 2 combined and against all other stages combined

When cancer stage was dichotomised, the variables of patient age and income domain remained significant results. All other variables were found to be non-significant.

5. 1. 7. Trend analysis

The decision was made to also conduct a trend analysis using the top and bottom deciles of each of the QOF domains and total score.

From the colorectal dataset only the patient experience domain deciles were significant against stage ($p = 0.035$). The three remaining QOF domains and total score were not significant.

Putting the data into deciles and only taking the top and bottom deciles was considered, as there might be a skew in the distribution of the cancer stage, i.e. those in the top decile will be mainly less advanced stage cases while the bottom decile will be more advanced stages. However, when colorectal cancer stage was cross-tabulated against each of the deciles it became clear that for colorectal cancer the distribution of different stages is representative across the deciles for each of the QOF domain and total scores.

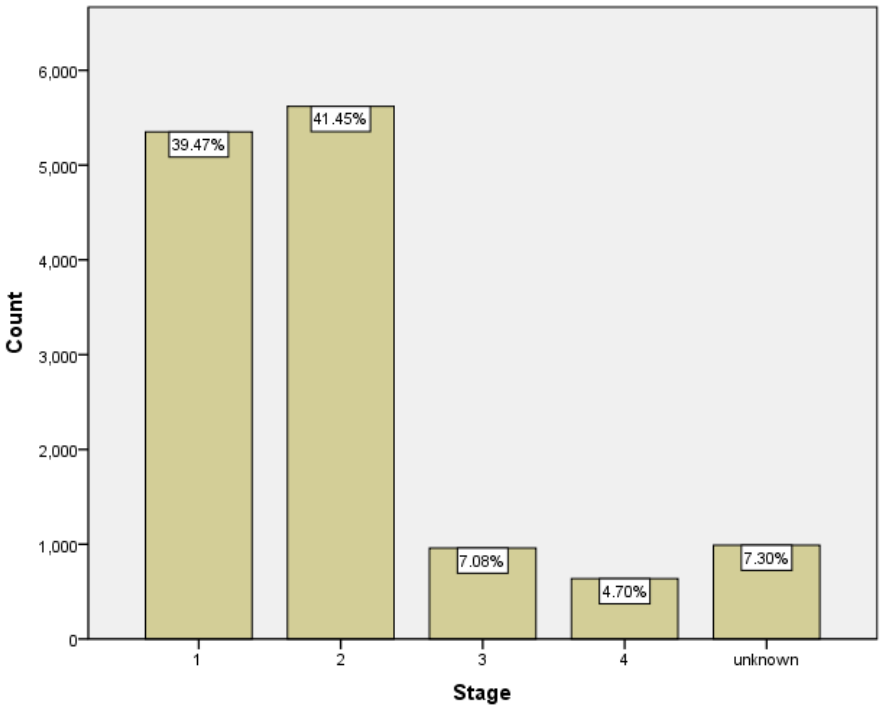
5. 2. Breast cancer

5. 2. 1. Descriptive and distribution analysis

Initially a basic breakdown of each of the cancer types was conducted and the breakdown for breast cancer was as follows.

Cancer stage ranged from 1-4 and unknown, stage 0 cases had been removed as detailed in chapter 4; methods. In the breast cancer dataset (n = 13,556) the majority of cases, 80.92% were recorded as stage 1 or 2. The more advanced stages, 3 and 4, constituted 11.78% of the cases in the dataset. National data for breast cancer stage in England shows that 41% were stage 1, 45% - stage 2, 9% - stage 3, 5% - stage 4, and 8% were unknown (Lyratzopoulos *et al.*, 2012a).

Figure 14. Distribution of breast cancer stage.



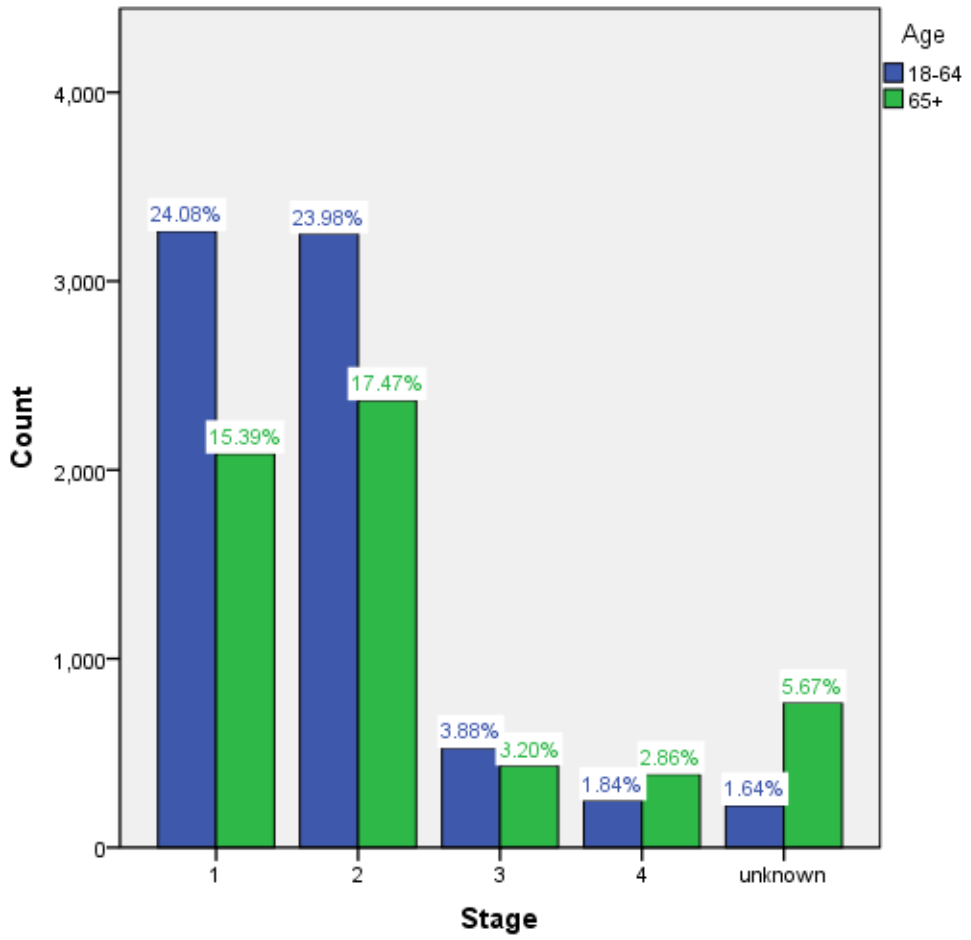
Within the patient information that was provided by NYCRIS, along with the cancer stage the key variables were age and income domain quintile. In the breast dataset, sex was disregarded as a variable due to the natural bias of breast cancer cases, where it is predominantly a female disease with nearly all cases being female. In this particular dataset there were male cases, n = 99, which constituted 0.7% of the total number of breast cancer cases.

Age had been categorised into working age (18-64) and retirement age (65+) and within the breast dataset the distribution was nearly equal with patients of working age making up 55.4% of the dataset while patients of retirement age made up 44.6%. National data for the effect of patient age on breast cancer stage has found that older patients, specifically those 70+ are more likely to be diagnosed with a more advanced stage of breast cancer (Lyratzopoulos *et al.*, 2012a).

Table 8. Cross tabulation of breast cancer stage and patient age.

Stage	Age		Total
	18-64	**65+**	
1	3264 (61%)	2086 (39%)	5350
2	3251 (57.9%)	2368 (42.1%)	5619
3	526 (54.8%)	434 (45.2%)	960
4	249 (39.1%)	388 (60.9%)	637
Unknown	222 (22.4%)	768 (77.6%)	990
Total	7512 (55.4%)	6044 (44.6%)	13556

Figure 15. Distribution of breast cancer stage by patient age.



A chi-square test to further analyse the relationship between breast cancer stage and age was conducted and produced a significant result, X^2 (4) = 586.32, p < .0001.

Income domain is separated into quintiles (range is therefore 1-5) with 5 representing the most deprived and one the least deprived. From the Figure 16 below it is difficult to see whether there is any variance in the distribution or potential relationship between the income domain and patient cancer stage due to the higher number of cases which have been diagnosed at the less advanced stages. National data in this area has shown that patients diagnosed with breast cancer are more likely to be living in more affluent areas, and are therefore more likely to have a higher income (income domain 1 = high level income; income domain 5 = low level income); however, it still remains that patients living

in deprived areas are more likely to be diagnosed with a more advanced cancer stage (Cuthbertson *et al.*, 2009, Rutherford *et al.*, 2013)(Downing *et al.*, 2007a). The Table 9 and Figure 16 below show the distribution of the data and a chi-square test found there to be a significant relationship between a patient's cancer stage and income domain level, X^2 (16) = 66.33, p < .0001.

Figure 16. Distribution of breast cancer stages by patient income domain.

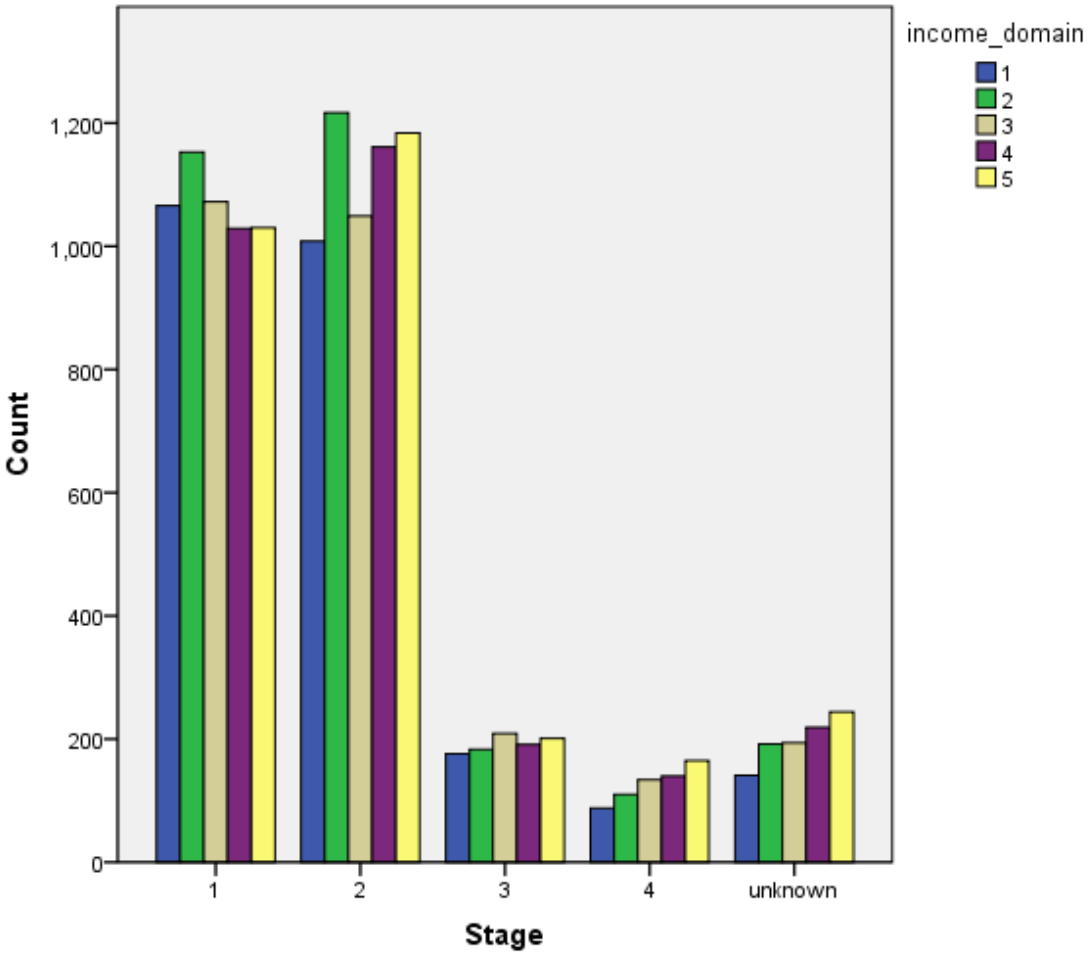


Table 9. A cross tabulation of patient income domain against cancer stage at diagnosis for breast cancer.

Stage	Income domain					Total
	1	2	3	4	5	
1	1066 (19.9%)	1153 (21.6%)	1072 (20%)	1029 (19.2%)	1030 (19.3%)	5350
2	1008 (17.9%)	1217 (21.7%)	1049 (18.7%)	1161 (20.7%)	1184 (21%)	5619
3	176 (18.3%)	183 (19.1%)	209 (21.8%)	191 (19.9%)	201 (20.9%)	960
4	88 (13.8%)	110 (17.3%)	134 (21%)	140 (22%)	165 (25.9%)	637
Unknown	141 (14.2%)	192 (19.4%)	194 (19.6%)	219 (22.1%)	244 (24.7%)	990
Total	2479 (18.3%)	2855 (21.1%)	2658 (19.6%)	2740 (20.2%)	2824 (20.8%)	13556

5. 2. 2. Screening data

In the case of breast cancer there is a national breast screening programme that was running during the time period that the data has come from. For colorectal cancer, while there are screening programmes in place now, they had not yet been implemented during 2006-2008.

For the time period of data requested NYCRIS also had information available regarding screening information and status recorded for patients; for example, whether they were diagnosed following screening or whether they had been screened but were over the guideline age range for the screening programme etc. Within the NYCRIS dataset for breast cancer there was 14,387 cases of breast cancer. Of these just over half (n = 8,636) have information related to screening, i.e. lapsed attender, overage etc., and of these half again were cases of screen detected cancer (n = 4,202). In total 35.6% of the breast cancer cases within the data were detected via screening.

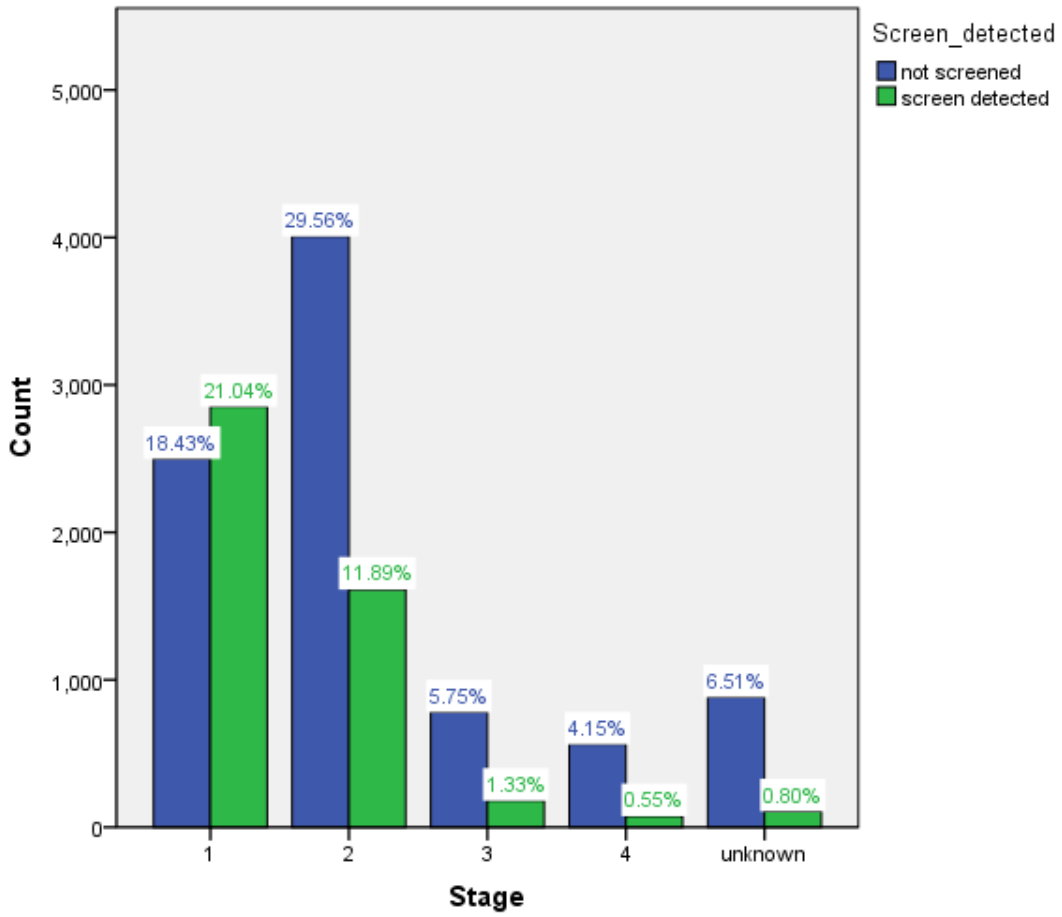
Where no information was available regarding whether a case was screen detected or not the decision was made to treat it as an unscreened case, therefore cases with no information were categorised with the cases which were not screen detected .

When looking at the cancer stage against the screening information, within the breast cancer cases, trends are observable in the impact that screening has. For those cases detected through screening over half (59.08%) were diagnosed at stage 1, compared with the cases which have no screening information where the majority (45.9%) of the cases were diagnosed at stage 2.

National data from 'the second all breast cancer report' (Lawrence *et al.*, 2011) found that in 2007, 32% of breast cancer cases were diagnosed via a screening pathway. It has also been reported that patients who are diagnosed through a screening pathway are also more likely to have a less advanced stage recorded at diagnosis.

A chi-square test did find the relationship between breast cancer stage and whether the cancer was screen detected or not to be significant, X^2 (4) = 1.40, $p < .0001$, and the distribution of the data is shown below in Figure 17.

Figure 17. Distribution of breast cancer stage by screening pathway.



5. 2. 3. QOF data

As detailed in the colorectal QOF results, the QOF data used was from the 2009/2010 and is divided into four domains and these culminate in total score, the maximum of which is 1,000 points. Within the breast cancer dataset there were 840 GP practices, Table 10 below shows a breakdown of the maximum and minimum scores for each of the domains and total score.

Table 10. Summary statistics of the QOF domain scores and QOF total score.

	Minimum	Maximum	Standard deviation	Mean	National average Verdecchia *et al.*, 2007b
Clinical domain	486	697	20.62	679.91	668.2
Organisational domain	98	168	6.94	164.05	161.4
Patient experience domain	30	92	17.75	63.48	65.4
Additional services domain	29	44	1.83	42.94	42.0
Total score	722	1000	32.37	950.02	936.9

The box plots show that there are a number of outlier practices which score much lower than the mean or even the standard deviation.

Figure 18. Distribution of QOF total scores against breast cancer stage.

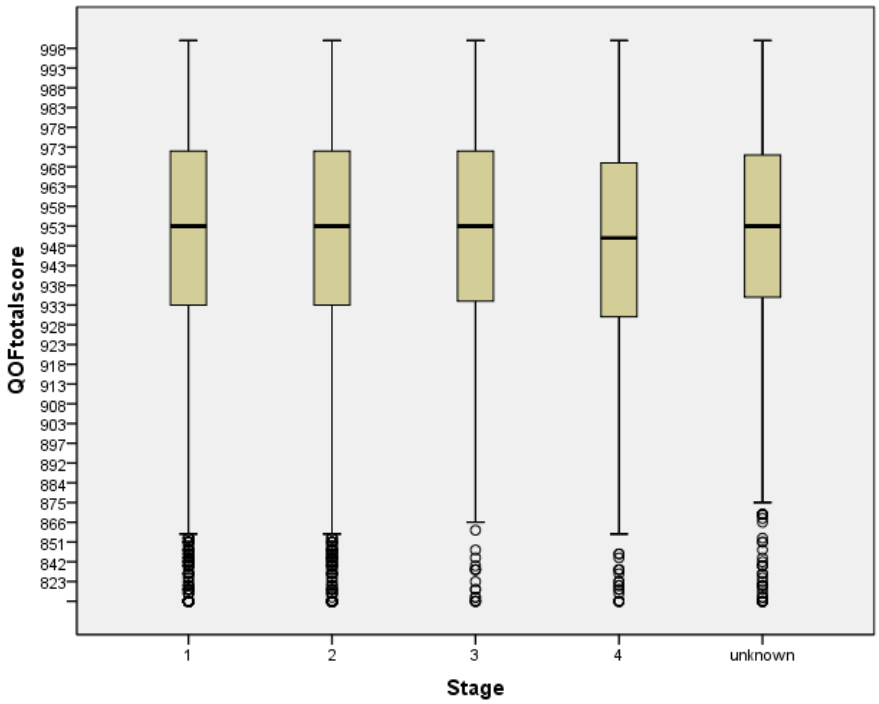


Figure 19. Distribution of QOF clinical domain scores against breast cancer stage.

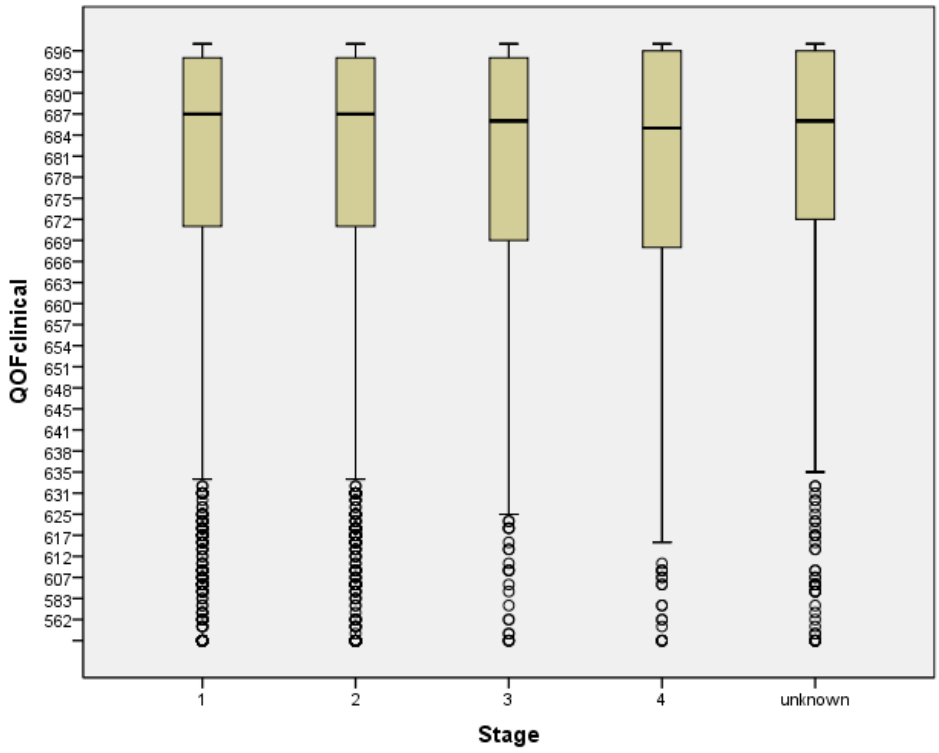


Figure 20. Distribution of QOF organisational domain scores against breast cancer stage.

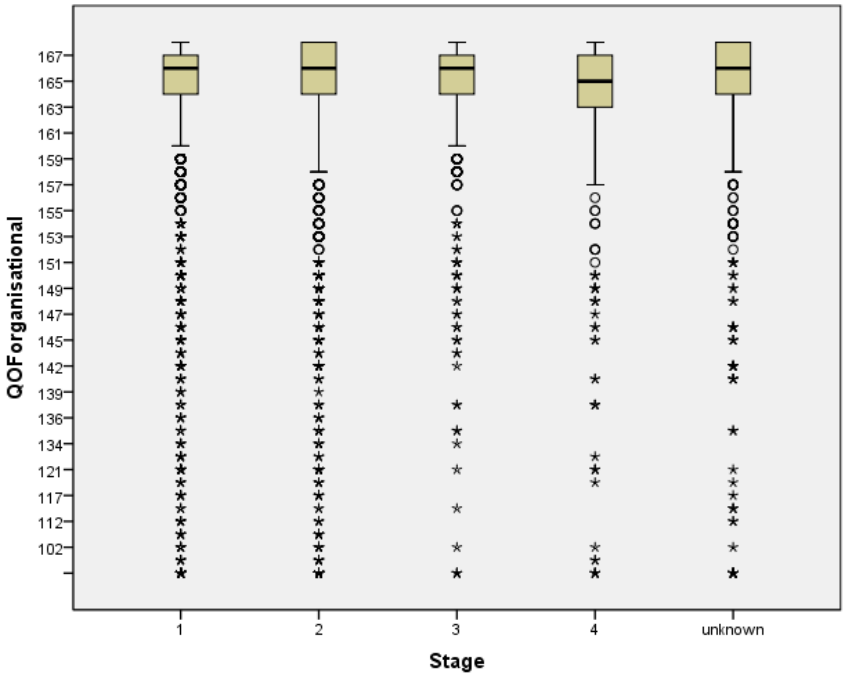


Figure 21. Distribution of QOF patient experience domain scores against breast cancer stage.

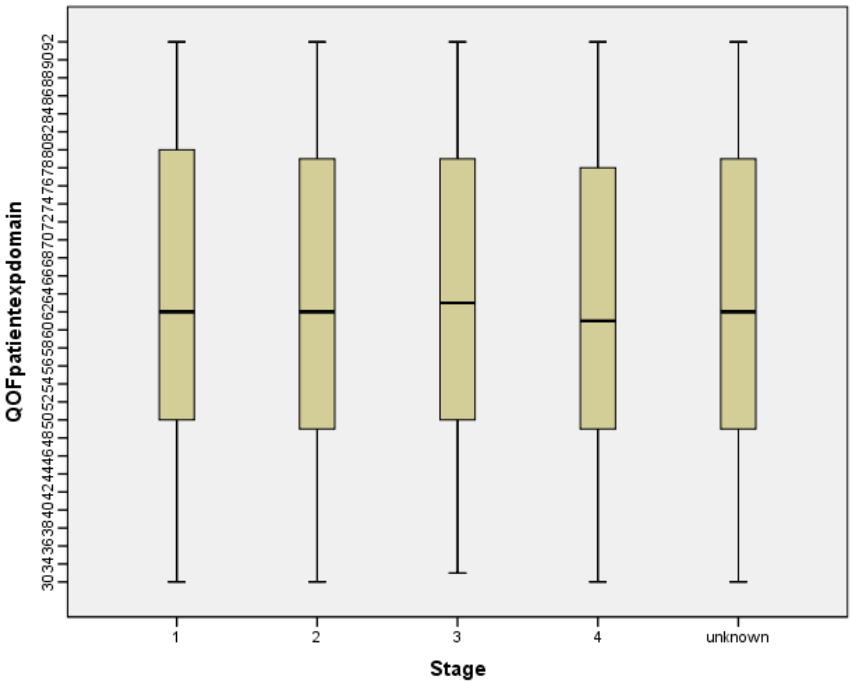
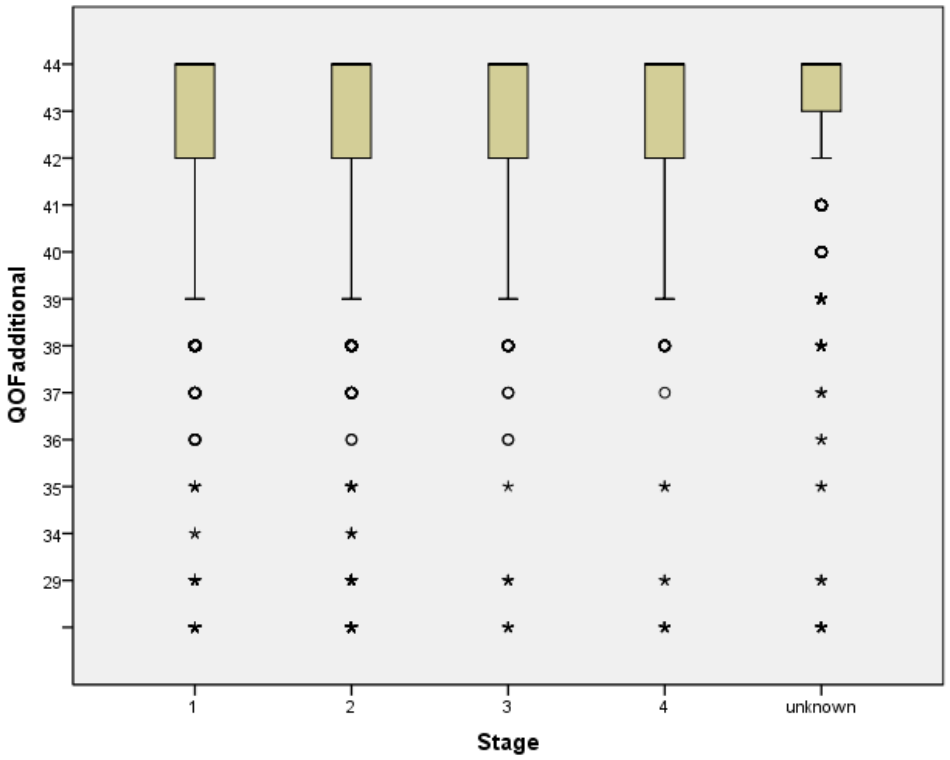


Figure 22. Distribution of QOF additional services domain scores against breast cancer stage.



5. 2. 4. Correlation matrixes

All breast cancer variables were put into a correlation matrix to investigate and establish whether there were already any existing correlations between the variables; see Appendix 3 Table 17. As with the colorectal dataset it was expected that certain variables would show a significant interaction as they are related or are components of each other.

This was again found to be the case when the deprivation variables were positively correlated with each other, at the $p < 0.05$ level.

Breast cancer stage was found to correlate with patient age, practice variables related to age (% of practice population over 65, % of patients over 75 and % of patients over 85), patient income domain and practice deprivation variables, and the specific practice variables of patient ability to see a doctor within two days.

The majority of individual QOF variables correlated with the total QOF score and the patient experience domain of QOF. The exceptions were in the clinical domain where the only individual variable that was non-significant was the percentage of patients unable to see their preferred GP; in the organisational domain the variable for exception rating was non-significant; and for the additional services domain the variables of the percentage of patients over 85, percentage able to see their preferred GP and patient ability to book an appointment were not found to be significant.

5. 2. 5. Regression

For the regression analysis, and following analyses, cases within the breast cancer dataset that had been identified and diagnosed through a screening pathway were removed. This decision was made as it was thought that these cases may obscure the results. The primary aim of this project is to investigate the potential association between GP practice quality and cancer stage at diagnosis. The breast cancer screening programme is a national programme conducted externally to GP practices, therefore GPs have little or no direct influence on screening detected breast cancer cases.

5. 2. 5. 1. Breast cancer data, excluding screening detected cases

5. 2. 5. 1. 1. Patient variable

Of the patient variables only age and a patient's income domain were found to produce any significant results.

Between stage 1 and stage 4 and unknown stage there was a significant finding for age and cancer stage at diagnosis. The RRR were 2.147 for stage 1 and stage 4 and 5.262 for stage 1 and stage unknown, with a RRR >1 this implies that a patient of retirement age,

compared to working age, is signficantly more likely to be diagnoised with a more advanced and unknown stage breast cancer.

The patient income domain produced a positive correlation at stage 4 against stage 1 breast cancer, with a RRR = 1.094. Thus as income domain increases, meaning that patients are earning a lower income, the likelihood of more advanced and unknown stage breast cancer increases.

5. 2. 5. 1. 2. QOF domains and total

The only significant results were between stage 1 versus stage 4 breast cancer. The QOF domains, clinical (RRR = .8209), organisational (RRR = .8198), patient experience (RRR = .8244) and additional services (RRR = .8028), produced rrr's <1, so as the QOF domain score decreased the prevalence of more advanced stage at diagnosis increased. The QOF total score (RRR = 1.218) also produced a significant result but it had a RRR <1 which suggests that as the QOF total score increases so does the prevalence of more advanced stage breast cancer.

5. 2. 5. 1. 3. Practice variables and GP/PCT codes

There were a number of specific practice variables which produced significant results.

Between stage 2 versus stage 1 the variable for patients being able to see their preferred GP was significant with a RRR = 1.6998.

Between stage 1 and unknown stage breast cancer the variables of; cancer review within six months of diagnosis, cancer prevalence rate within practice, patients' satisfaction with opening hours, and percentage of patients aged 85+, were all significant.

All other specific practice variables were found to be not significant, these were; exception rate for cancer indicators, percentage of patients aged 65+, deprivation score for the practice, IDAOPI, percentage satisfied with phone access, percentage able to see doctor within two days, percentage able to book appointment >= 2 days ahead, and percentage aged 75+.

Table 11. Baseoutcome output for breast cancer, screen detected cases removed, base outcome is stage 1.

Full output is available in appendix (6).

Multinomial logistic regression — Number of obs = 8689
LR chi2(105) = 631.59
Prob > chi2 = 0.0000
Log likelihood = -11532.981 — Pseudo R2 = 0.0267

Stage	Variable	Relative Risk Ratio (rrr)	Standard error	z	P>[z]	[95% confidence interval]
1 v 2	Ability to see preferred GP	1.699	.4668	1.93	0.053	.9922 2.912
1 v 4	Age	2.147	.2071	7.92	0.000	1.777 2.594
	Income domain	1.094	.0436	2.25	0.025	1.011 1.183
	QOF clinical domain	.8209	.0635	-2.55	0.011	.7055 .9552
	QOF organisational domain	.8198	.0631	-2.58	0.010	.705 .9534
	QOF patient experience domain	.8244	.0637	-2.50	0.012	.7085 .9592
	QOF additional services domain	.8028	.0649	-2.72	0.007	.6852 .9407
	QOF total score	1.218	.0940	2.55	0.011	1.047 1.417
1 v Unknown	Age	5.262	.4884	17.90	0.000	4.387 6.312
	Cancer prevalence within practice population	4.44e+08	4.05e+09	2.19	0.029	7.778 2.54e+16
	Cancer review conducted within 6 months	.3242	.1580	-2.30	0.021	.1247 .8428
	Patients' satisfaction with opening hours	13.086	12.67	2.66	0.008	1.962 87.29
	Percentage of patients aged 85+	3.05e-11	3.15e-10	-2.34	0.019	4.87e-20 .0191

5. 2. 5. 2. Top and bottom deciles of the breast cancer dataset

When the regression analysis was repeated with just the top and bottom 10% of practices, based on the QOF total score, many of the significant results remained or strengthened.

On the patient level, age remained significant and the RRR increase to 2.325 between stage 1 and stage 4 and 6.022 for stage 1 and stage unknown.

The four QOF domains and the QOF total score remained significant between stage 1 and stage 4 breast cancer. The QOF domains and QOF total score also became significant between stage 1 and stage 3. The QOF domains, clinical (RRR = .7022), organisational (RRR = .7158), patient experience (RRR = .6978) and additional services (RRR = .6366), produced rrr's <1, so as the QOF domain score decreased the prevalence of more advanced stage at diagnosis increased. The QOF total score (RRR = 1.429) also produced a significant result but it had a RRR <1 which suggests that as the QOF total score increases so does the prevalence of more advanced stage breast cancer.

Between stage 1 and stage 2 breast cancer the specific variable of a patient's ability to see a doctor within two days became significant with a RRR of .1239.

Between stage 1 and unknown stage breast cancer, the variable of a patient's satisfaction with opening hours remained significant and between stage 1 and stage 4 the variable of percentage of patients' satisfied with phone access became significant.

All other specific practice variables were found to be not significant, these were; cancer review within six months of diagnosis, cancer prevalence rate within practice, exception rate for cancer indicators, deprivation score for the practice, IDAOPI, percentage satisfied with phone access, percentage able to see doctor within two days, percentage able to book

appointment >= 2 days ahead, percentage of patients aged 65+, percentage aged 75+, and percentage of patients aged 85+.

Table 12. Baseoutcome output for breast cancer, screen detected cases removed, with just top and bottom deciles of QOF total score.

Full output is available in appendix (7).

Multinomial logistic regression — Number of obs = 1727
LR chi2(105) = 195.28
Prob > chi2 = 0.0000
Log likelihood = -2194.4279 — Pseudo R2 = 0.0426

Stage	Variable	Relative Risk Ratio (rrr)	Standard error	z	P>[z]	[95% confidence interval]
1 v 2	Ability to see GP within two days	.1239	.1239	-2.09	0.037	.0174 .8795
1 v 3	QOF clinical domain	.7022	.1199	-2.07	.038	.5025 .9813
	QOF organisational domain	.7158	.1225	-1.95	.051	.5118 1.001
	QOF patient experience domain	.6978	.1202	-2.09	.0367	.4978 .978
	QOF additional services domain	.6366	.1121	-2.57	.010	.4509 .8989
	QOF total score	1.429	.2349	2.09	.037	1.022 1.996
1 v 4	Age	2.325	.5205	3.77	<.0001	1.499 3.606
	QOF clinical domain	.5883	.1219	-2.56	.010	.3920 .883
	QOF organisational domain	.5850	.1210	-2.59	.010	.3900 .8775
	QOF patient experience domain	.5954	.1238	-2.49	.013	.3962 .895
	QOF additional services domain	.5638	.1221	-2.65	.008	.3688 .862
	QOF total score	1.706	.3533	2.58	.010	1.137 2.56
	Percentage satisfied with phone access	8.618	9.631	1.93	.05	.9642 77.03

1 v Unknown	Age	6.023	1.25	8.66	<.0001	4.011 9.043
	Patient satisfaction with opening hours	115.16	270.37	2.02	.043	1.156 11473.3

The regression analysis was repeated with the breast dataset being separated into deciles based on each of the four QOF domains individually. Therefore, the regression analysis was repeated with data from the top and bottom deciles of the QOF clinical domain, then repeated with the data from the top and bottom deciles based on the QOF organisational domain and so on. The following variables were all found to be non-significant across the four analyses; exception rate for cancer indicators, deprivation score for the practice, percentage able to book appointment >= 2 days ahead, percentage aged 75+, and percentage aged 85+.

The significant results are as follows:

5. 2. 5. 2. 1. Clinical domain

Age was found to be significant between stage 1 and stage 2, 4 and unknown, these all had rrr's >1 which implies that as patient age increases so does the likelihood of their diagnosis being recorded as a more advanced stage of breast cancer or stage unknown.

Between stage 1 and stage 4 patient income domain was significant with a RRR of 1.1997, so as patient income domain increases (and therefore their deprivation) so does the likelihood that they will have a more advanced stage recorded at diagnosis. The practice variable of IDAOPI was significant between stage 1 and stage 2, with a RRR of .0296.

Some specific practice variables were found to be significant between certain stages, specifically stage 1 versus 3 and unknown stage patient ability to see their preferred GP, the rrr's were both >1, between stage 1 versus unknown stage GP practice opening hours was signifcant with a RRR >1, and stage 1 versus stage 4 the additional services domain of QOF and the practice variable of a cancer review being conducted within six months were both significant and with rrr's <1.

5. 2. 5. 2. 2. Organisational domain

Age was found to be significant between stage 1 and stage 4 and unknown, these had rrr's of 1.717 and 4.712 respecticaly, suggesting that as a patient's age increases so does the likelihood of their diagnosis being recorded as a more advanced stage of breast cancer or stage unknown.

A patient's income domain was signicant between stage 1 and stage 4 with a RRR = 1.155, while the specific practice variable of a patient's ability to see their preferred GP was significant across stage 1 versus stage 2 and 4, with rrr's >1. Between stage 1 and stage unknonw the prevelance rate of cancer within a practice was signicant with a RRR >1 and between stage 1 versus stage 4 all the QOF domains were significant with rrr's <1 while the QOF total score was significant with a RRR >1.

5. 2. 5. 2. 3. Patient experience domain

Age was found to be significant between stage 1 and stage 4 and unknown, these were rrr's >1 suggesting that as a patient's age increases so does the likelihood of their diagnosis being recorded as a more advanced stage of breast cancer or stage unknown.

Between stage 1 versus stage 3 and 4 all the QOF domains were significant, except the additional services domain between stage 1 and stage 4, with rrr's <1, while the QOF total score was significant with rrr's >1.

The specific practice variable for a patient's satisfaction with phone access was found to be significant with a RRR of .0742, which suggests that as a patient's satisfaction increases they are more likely to be diagnoised with a less advanced breast cancer stage.

5. 2. 5. 2. 4. Additional services domain

Age was found to be significant between stage 1 and stage 4 and unknown, these were with rrr's >1 suggesting that as a patients' age increases so does the likelihood of their diagnosis being recorded as a more advanced stage of breast cancer or stage unknown.

Patient income domain between stage 1 against stage 4 and unknown was significant and had rrr's >1, which suggests as a patient deprivation increases so does the likelihood of their being diagnoised with a more advanced or unknown breast cancer stage.

Between stage 1 versus unknown the specific practice variables of the GP practice opening hours, and whether a cancer review had been conducted within six months were all significant.

Between stage 1 versus stage 4 all the QOF domains were significant, with rrr's <1, while the QOF total score was significant with rrr's >1.

As mentioned in the colorectal cancer results there is the concern that, due to the large number of variables in this analysis a type one error may occur and significant results may be found by chance rather than because they are statistically significant. The 'prob > chi2', a measure of 'good-fit', and 'pseudo R2', which is McFadden's pseudo R-adjusted, and these were all <0.05 for the breast cancer regression analyses.

A marginal effects analysis was additionally conducted to further investigate, and this found that there were significant results for a patient's income domain, percentage of elderly patients within a practice, and patient satisfaction with opening hours of the practice.

5. 2. 6. Multi-level model

The regression analysis produced a number of results whereby practice variables were found to have a significant affect upon cancer stage at diagnosis, most notably the QOF domains and total score. This was reflected in the multi-level analysis which showed that GP practices and also the PCT contribute to the variance between breast cancer stage at diagnosis.

5. 2. 6. 1. All breast data, screening detected cases excluded

Between the different cancer stages between 12% and 18% of the variance was attributed to the patients' GP practice, it was only between stage 1 and 4 where GP practice did not show any significant affect (<0.0001%).

At the PCT level it was only between stage 1 and 4 that any variance was found, 11%, while between other stages the variance was found to be less than 0.001%.

Table 13. Multi-level variance at GP and PCT level for breast cancer with screening cases excluded.

Stage	GP	PCT
1 v 2	12%	0.0001%
1 v 3	18%	0.0001%
1 v 4	0.0001%	11%
1 v unknown	13%	0.0001%

5. 2. 6. 2. Breast cancer data with screening detected cases excluded and just the top and bottom 10% of practices included

When just the top and bottom deciles of the QOF total score was included, the GP practice was found to account for between 16-29% of the variance between the cancer stages at diagnosis.

On the PCT level variance ranged between 5-21%, except when stage 1 was compared against stage 3 where the variance attributed to PCT became < 0.001%.

Table 14. Multi-level variance at GP and PCT level for breast cancer with screening cases excluded and just top and bottom deciles.

Stage	GP	PCT
1 v 2	21%	5%
1 v 3	26%	0.0001%
1 v 4	16%	21%
1 v unknown	29%	7%

5. 2. 7. Dichotomised stage

As with the colorectal dataset, additional analyses were conducted with the breast cancer stages dichotomised, combining stage 1 and 2 together, and combining stage 3, 4 and unknown together.

5. 2. 7. 1. Breast cancer stage 1 & 2 combined and against all other stages combined

When cancer stage was dichotomised, age and whether the cancer was detected through a screening pathway, were the only significant findings; both were a positive coefficient.

When the analysis was done with the top and bottom deciles for the QOF total score the finding with age remained and each of the individual QOF domains along with the total QOF score also became significant results, with all of the domains being negative coefficients and the total QOF score a positive coefficient.

These findings remained when the top and bottom deciles for the patient experience domain were compared. Patient age and the QOF domains and total score remained as significant results and when the top and bottom deciles for the clinical domain were compared the finding for the patient variable of age remains but the QOF domain and total scores become non-significant.

5. 2. 8. Trend analysis

A trend analysis was conducted using the top and bottom deciles of each of the four QOF domains and the QOF total score against breast cancer stage.

There were no significant findings from any of these analyses.

5. 2. 9. Screening age patients removed

As mentioned in chapter 4, there was concern about possible screening effects, similar to a Hawthorne effect, in the breast cancer data.

Once patients aged between 50-70 years old were removed a total of n = 6,373 patients remained. Some descriptive analysis was conducted to observe disributions, in the

case of stage at diagnosis this remained consistent with the larger dataset, with the majority of cases being diagnosed at stage 1 (39.7%) and stage 2 (40.9%).

The distribution of screening information was also conducted and it was found that 34.77% (n = 2,216) were cases which had been detected and diagnosed through screening, the most likely explaination for this is patients entering the screening programme early due to family history, and 20.6% of the screen detected cases where patients were overage (70+) but had remained in the screening programme.

These screen detected cases were additionally removed and the analyses repeated.

5. 2. 9. 1. Regression analysis

5. 2. 9. 1. 1. Patient variable

Of the patient variables, age and a patient's income domain were found to produce significant results.

Between stage 1 and stage 4 and unknown stage there was a significant outcome between age and cancer stage at diagnosis, both with rrr's >1 which suggests that a patient of retirement age, compared to a patient of working age, is significantly more likely to be diagnoised with a more advanced and unknown stage breast cancer.

The patient income domain produced a positive correlation at stage 4 against stage 1 breast cancer, this had a RRR of 1.148. Thus as income domain increases, meaning that patients are earning a lower income, the likelihood of more advanced and unknown stage breast cancer increases.

5. 2. 9. 1. 2. QOF domains and total

The only significant results were between stage 1 versus stage 4 breast cancer. The QOF domains, clinical, organisational, patient experience and additional services, produced rrr's <1, so as the QOF domain score decreased the prevalence of more advanced stage at diagnosis increased. The QOF total score also produced a significant result but it had a RRR >1 which suggests that as the QOF total score increases so does the prevalence of more advanced stage breast cancer.

5. 2. 9. 1. 3. Practice variables and GP/PCT codes

There were a number of specific practice variables which produced significant results, these included:

Between stage 2 versus stage 1 the variable for patients being able to see their preferred GP was found to be signifcant.

Variables related to age and the propoportion of elderly patients within a practice were also significant when stage 3, 4 and unknown were compared against stage 1, specifically the variables were, the percentage of elderly (65+) patients within a practice, the percentage of patients aged over 75, and the percentage of patients aged over 85.

Between stage 1 and unknown stage breast cancer, the practice variable of cancer prevalence rate were significant, as was satisfaction with practice opening hours.

All other specific practice variables were found to be not significant, these were; cancer review within six months of diagnosis, deprivation score for the practice, IDAOPI, percentage satisfied with phone access, exception rate for cancer indicators, percentage able to see doctor within two days and percentage able to book appointment >= 2 days ahead.

Table 15. Base outcome output for breast cancer, screen detected cases and patients of screening age removed.

Full output is available in appendix (8).

Multinomial logistic regression — Number of obs = 4101
LR chi2(105) = 441.42
Prob > chi2 = 0.0000
Log likelihood = -5292.1196 — Pseudo R2 = 0.0400

Stage	Variable	Relative Risk Ratio (rrr)	Standard error	z	P>[z]	[95% confidence interval]
1 v 2	Patient's ability to see preferred GP	2.345	.9388	2.13	0.033	1.070 5.139
1 v 3	Percentage of elderly patients (65+)	9.19e-06	<.0001	-2.36	0.018	6.01e-10 .1406
	Percentage of patients aged 75+	1.74e+11	1.80e+12	2.49	0.013	257.11 1.18e+20
1 v 4	Age	2.424	.3522	6.10	0.000	1.823 3.223
	Income domain	1.148	.0684	2.32	0.020	1.022 1.290
	QOF clinical domain	.7602	.088	-2.37	0.018	.6059 .9547
	QOF organisational domain	.7644	.0880	-2.33	0.020	.6099 .9579
	QOF patient experience domain	.7509	.0870	-2.47	0.014	.5982 .9425
	QOF additional services domain	.6997	.8491	-2.94	0.003	.5516 .8876

	QOF total score	1.317	.1523	2.38	0.017	1.05 1.65
	Percentage of elderly patients (65+)	451355.4	2686717	2.19	0.029	3.869 5.46e+10
	Percentage of patients aged 75+	2.02e-14	2.56e-13	-2.48	0.013	3.15e-25 .0013
1 v unknown	Age	5.4609	.7724	12.00	0.000	4.139 7.205
	Cancer prevelance	3.98e+18	5.46e+19	3.12	0.002	8307295 1.90e+30
	Patient satisfaction with opening hours	24.42	35.20	2.22	0.027	1.447 411.96
	Proportion of patients aged over 85+	4.62e-14	7.05e-13	-2.01	0.044	4.65e-27 .4593

5. 2. 9. 1. 4. Top and bottom deciles of the breast cancer dataset with screening age removed

Based on the QOF total score, some of the results changed when the regression analysis was repeated without the screening age patients and with just the top and bottom 10% of practices.

On the patient level, age remained significant between stage 4 and unknown stage against stage 1, but income domain was no longer significant.

The four QOF domains and the QOF total score were no longer significant between stage 1 and stage 4 breast cancer, but the additional services domain became significant between stage 3 and stage 1.

At stage 4 versus stage 1 breast cancer the specific practice variables of a cancer review within six months, percentage of elderly (65+) patients at the practice, percentage of patients satisfied with phone access, and percentage of patients over 75 all became significant.

Between stage 1 and unknown stage breast cancer the variable of proportion of cancer prevelance within a practice became significant.

All other specific practice variables were found to be not significant, these were; patient income domain quintile, exception rate for cancer indicators, deprivation score for the practice, IDAOPI, percentage able to see their prefered GP, percentage able to see doctor within two days, percentage able to book appointment >= 2 days ahead, and percentage of patients aged 85+.

The analysis was repeated with each of the four QOF domains, taking the top and bottom deciles in each, the significant results are as follows:

Table 16. Base outcome output for breast cancer, screen detected cases and screening age patient removed, with just top and bottom deciles of QOF total score.

Full output is available in appendix (9).

Multinomial logistic regression — Number of obs = 828
LR chi2(105) = 171.36
Prob > chi2 = 0.0000
Log likelihood = -1036.5142 — Pseudo R2 = 0.0764

Stage	Variable	Relative Risk Ratio (rrr)	Standard error	z	P>[z]	[95% confidence interval]
1 v 3	QOF additional services domain	.5713	.1406	-2.28	0.023	.3527 .9254
1 v 4	Age	3.279	1.176	3.31	0.001	1.624 6.622
	Cancer review within six months	.0667	.0868	-2.08	0.037	.0052 .8534
	Percentage of elderly patients (65+)	1.78e+16	2.84e+17	2.35	0.019	490.5 6.47e+29
	Percentage satisfied with phone access	370.1	741.5	2.95	0.003	7.292 18783.1
	Percentage of patients aged over 75	6.09e-37	1.98e-35	-2.57	0.010	1.40e-64 2.65e-09
1 v unknown	Age	6.293	1.869	6.19	0.000	3.516 11.26
	Cancer prevalence	1.20e+28	3.98e+29	1.95	0.05	.7596 1.90e+56

5. 2. 9. 1. 5. Clinical domain

Age was found to be significant between stage 1 and stage 4 and unknown, these both had rrr's >1 suggesting that as a patient's age increases so does the likelihood of their diagnosis being recorded as a more advanced stage of breast cancer or stage unknown.

Additional practice variables related to age were found to be significant between stage 1 and stage 3, these were the proportion of elderly (65+) patients within the practice and percentage of patients aged 75+ within the practice.

Between stage 1 and stage unknown patient income domain was a significant result with a RRR of 1.207, so as patient income domain increases (and therefore their deprivation) so does the likelihood that they will have a more advanced or unknown stage recorded at diagnosis.

Some specific practice variables were found to be significant between certain stages, specifically stage 1 versus 4 the variable of cancer review within six months was significant and between stage 1 versus unknown cancer prevelance within the practice was also significant.

5. 2. 9. 1. 6. Patient experience domain

Age was found to be significant between stage 1 and stage 4 and unknown.

The specific practice variables of a patient's ability to see their preferred GP and patient satisfaction with practice opening hours was significant between stage 1 and 2. Also between stage 1 versus stage 4 all the QOF domains were significant with rrr's <1, while the QOF total score was significant with a RRR of 2.324.

The rate of cancer prevelance within a practice was signficiant between stage 1 and unknown stage.

5. 2. 9. 1. 7. Organisational domain

Age was found to be significant between stage 1 and stage unknown, with a RRR of 3.887, suggesting that as a patient's age increases so does the likelihood of their diagnosis being recorded as a more advanced stage of breast cancer or stage unknown.

Patient income domain was signifcant with a RRR of 1.276 between stage 1 and stage 4 breast cancer.

Between stage 1 versus stage 4 all the QOF domains were significant with rrr's <1, while the QOF total score was significant with a RRR of 1.840 .

Specific variables which were significant were between stage 1 and stage 2 where the percentage of patients able to see their preferred GP was significant, and between stage 1 and stage unknown where the rate of cancer prevelance was also significant.

5. 2. 9. 1. 8. Additional services domain

Age was found to be significant between stage 1 and stage 4 and stage unknown. Between stage 1 versus stage 4 the practice variables of the proportion of elderly patients (65+) and the proportion of patients aged over 75 were found to be significant.

Patient income domain was significant between stage 1 and stage 4 and unknown stage, both with rrr's >1.

Between stage 1 and stage 4 the additional services domain of QOF was significant with a RRR of .7510. Remaining significant results were the specific practice variables of cancer

prevalence within the practice, the exception rate of the practice and patient satisfaction with practice opening hours, which were all signifcant between stage 1 and unknown stage.

5. 2 .9 .1 .9. Multi-level model

5. 2. 9. 1. 9. 1. All breast data, screening detected cases and patients of screening age excluded

A multi-level analysis was repeated on this dataset.

Between stage 1 versus stage 2 and unknown stage between 17.5% and 24.9% was attributed to the GP practice level, while between stage 1 versus stage 3 and stage 4 variance was <0.0001%. At the PCT level between stage 1 and stage 3 had the highest variance attributed to PCT level, 13.1%, while at all other stages it was 0.0002% or lower.

Table 17. Multi-level variance at GP and PCT level for breast cancer with screening detected case and patients of screening age excluded.

Stage	GP	PCT
1 v 2	24.9%	0.0002%
1 v 3	<0.0001%	13.1%
1 v 4	<0.0001%	0.0002%
1 v unknown	17.5%	0.0001%

5. 2. 9. 1. 9. 2. All breast data, screening detected cases and patients of screening age excluded and just the top and bottom deciles based on practices total QOF score.

With this repeated analysis the variance attributed to GP practice level ranged between 32.14% and 42.9%, while at the PCT level the highest variance was 0.0009% between stage 1 and stage 3 breast cancer.

Table 18. Multi-level variance at GP and PCT level for breast cancer with screening cases and patients of screening age excluded and just top and bottom deciles.

Stage	GP	PCT
1 v 2	32.14%	<0.0001%
1 v 3	36.66%	0.0009%
1 v 4	41.79%	<0.0001%
1 v unknown	42.9%	0.0005%

6. Chapter 6 – Discussion

This chapter brings together and discusses the information so far presented within this thesis. This includes a summary of the findings and a detailed interpretation of the results from the different analyses which were conducted. Possible explanations for the findings and overlaps with current research are also discussed, along with where the findings fit within the wider context of this research area.

6. 1. Aims and objectives

- The aim of this project was to investigate whether there was a relationship between GP practice quality and patient cancer stage at diagnosis.
- The objective of this project was to use a secondary data analysis method by utilising and obtaining data from existing health databases is order to analyse if there was a potential link between GP practice quality and patient cancer stage at diagnosis in breast and colorectal cancer in the North East region of England.

6. 2. Key findings

The objective of this research project was met, in that data was obtained from existing health databases, specifically NYCRIS, the GP practice profiles and the NHS IC, and analysis was successfully carried out to investigate the potential link between GP practice quality and cancer stage at diagnosis. This research project also met the aim by finding a link between GP practice quality and cancer stage in breast cancer and links between aspects of GP practice quality and both breast and colorectal cancer stage.

Specifically, between 12% and 18% of the variance in breast cancer stage at diagnosis could be attributed to the variance at the GP practice level. When just the top and bottom 10% of practices, based on their QOF total score were compared, this increased to between 16% and 29%. It was also observed that the PCT a practice was located in also contributed to some of the variance in cancer stage at diagnosis. Specifically when stage 1 and stage 4 were compared, 11% of the variance was attributable to the PCT and when just the top and bottom 10% of practices were analysed this increased to 21%.

A range of analyses were conducted to try and identify and understand more specific variables that could influence a patient's cancer stage at diagnosis. From the regression

analysis of the breast cancer data some specific variables relating to quality were found to have a significant effect upon cancer stage at diagnosis. The QOF total score and each of the individual domains were found to be significant, as well as: the prevalence of cancer within a practice, whether a patient is given a review by their GP within six months of diagnosis, a patient's ability to see their preferred GP when making an appointment and the opening hours of the GP practice.

For colorectal cancer evidence of a link between GP practice quality and cancer stage at diagnosis was not found. In the regression analysis, where specific variables which make up the QOF scores were individually analysed, a significant link was found between one of the variables, patient ability to see a GP within two working days, and patient cancer stage at diagnosis.

Patient income domain and practice deprivation had a significant effect on cancer stage at diagnosis in both breast and colorectal cancer. That as deprivation and patient income domain increased so does the likelihood and relative risk of the patient being diagnosed with a more advanced or unknown cancer stage.

Age was found to be a significant variable in both cancers, in colorectal cancer as age decreased the likelihood of being diagnosed with a more advanced or unknown cancer stage increased. However, in the breast cancer analysis the reverse was found, as patient age increased so did the likelihood and relative risk of a more advanced or unknown cancer stage.

Patient sex was not included as a variable in the breast dataset, due to it being a predominantly female disease. For the colorectal analyses it was not found to contribute or have a significant influence on colorectal cancer stage.

6. 3. Interpretation of findings

To begin with, a number of descriptive and distributional analyses were conducted to further examine and understand the make-up of the data that had been brought together. When investigating the QOF data it was found that the overall QOF score and individual domains were positively skewed, with many of the practices scoring the maximum amount or close to maximum score. This effect is well documented, as it serves a purpose for the practice to meet QOF standards and obtain as high a score as possible to receive the maximum amount of funding (Department of Health, 2002, Downing *et al.*, 2007b, Steel and Willems, 2010). However, what was identified in this project was while the majority of practices scored highly, there were a number of outlying practices which scored significantly lower, and even below national averages.

Previous research has identified a number of practice characteristics which can affect and influence QOF scores and attainment, specifically the size of a practice (Wang *et al.*, 2006) and the deprivation level of the area the practice is located in (Wright *et al.*, 2006). A correlation was found between QOF domains (excluding the additional services domain) and total score and deprivation levels within a practice and patient income domain in both breast and colorectal cancer. Therefore, it could be suggested that these outlying practices are potentially located in deprived areas and as such are attaining lower QOF scores because of this.

The exception to this was the patient experience domain. The distributions for this particular domain did not produce any outliers; one possible explanation for this could be that the patient experience domain is smaller (max. of 92 points) in comparison to the clinical (max. of 697 points) and organisational (max. of 168 points) domains. However, the additional services domain is the smallest with a maximum points score of 44, and outliers

were found when the distribution was observed in both breast and colorectal cancer. Scores for the patient experience domain come from the GP patient survey so a possible explanation could be the survey itself, that there is little variation in this domain because the results of the survey are biased or have little variation.

The GP patient survey is a national level survey that has been conducted annually since 2007, and bi-annually since 2011. Responses from the survey contribute to the patient experience domain of QOF and previous research has identified that variance in responses is low, with a significant number of respondents reporting high levels of satisfaction (Kontopantelis *et al.*, 2010, Roland *et al.*, 2009). In addition, in their assessment of the GP patient survey Campbell *et al.* (2013) found a positive bias within their data, of patients having a favourable impression of primary care. More recent research has now specifically linked the GP survey and QOF, to investigate the effect of patient experience on quality of primary care (Llanwarne *et al.*, 2013) and confirms, as this project suggests, associations between QOF and quality of care with patient experience.

Patient surveys are reguarly used within research as an outcome measure, equally they are used to create healthcare measures such as the patient experience domain of QOF with little evidence base regarding their validity. While, as highlighted above, there is a range of previous research which has looked at bias and experience of respondents it is only recently that the validity of individual items within the GP patient survey has been researched. Lyratzopoulos et al. (2011) investigated the reliability and correlations of the individual questions within the GP patient survey, finding that while a small sub-set of questions had lower relliability the majoirty of questions had excellent reliability.

A correlation analysis was also conducted to investigate how the range of variables within the data interacted, particularly as some of the variables contribute to each other. As expected, the QOF domain scores and QOF total score were found to correlate with the

majority of specific QOF and practice profile indicators in both the breast and colorectal data.

Variables related to deprivation (patient income domain, practice deprivation score and IDAOPI (Income Domain Affecting Older People Index)), were found to correlate together in both the breast and colorectal cancer data. This was an unsurprising finding as patient income domain contributes to indicators of deprivation, such as the Index of Multiple Deprivation (IMD), which is then used to calculate scores such as practice deprivation and IDAOPI.

The QOF total score and variables associated with deprivation were found to correlate together, again this is an established and well recognised association, that practices in deprived areas attain lower scores in QOF (Wright *et al.*, 2006, Downing *et al.*, 2007b).

6. 3. 1. Colorectal

The distribution and descriptive analyses showed that there were a greater number of patients of retirement age (73.3%) compared to working age (26.7%) and this is a commonly observed and expected distribution within cancer populations, as aging is known to be a key cause of the development of cancer (Rutherford *et al.*, 2013, Boreham *et al.*, 2002).

The sex distribution of cases was nearly even, with 43% of cases being female and 57% male, and this is in line with national statistics for colorectal cancer (Cancer Research UK, 2013).

In the correlation analysis it was found that patient cancer stage at diagnosis and patient income domain were correlated; those who had a higher income domain quintile and therefore were receiving more financial support and benefits were more likely to have

a more advanced or unknown stage of cancer. This is a well-established correlation, that patients of low socio-economic status, of which a low income is a part, tend to have more advanced stages of cancer at diagnosis. It is also a common association that patients from low socio-economic backgrounds have higher incidence rates of cancer (Una *et al.*, 2000, Kontopantelis *et al.*, 2010, Lyratzopoulos *et al.*, 2011, Roland *et al.*, 2009).

In the regression analysis when stage 1 and stage 4 were compared it was found that patient age had a significant effect. A RRR of .8313 shows that patients of working age were more likely to be diagnosed with the more advanced stage 4, compared to patients of working age. Similar findings have been found in previous research, specifically, Bowel Cancer UK (2012) conducted research into the experiences of younger bowel cancer patients and found that 69% of younger patients were diagnosed with a more advanced or unknown stage of cancer. It is suggested that this may be due to preconceptions regarding the age profile of high risk patients. Increasing age is established as a risk factor and cause of cancer (Rutherford *et al.*, 2013, Adams *et al.*, 2004a, Boreham *et al.*, 2002, Collerton *et al.*, 2009), and in colorectal cancer the focus has been on the high risk to older populations. This was certainly the finding of Bowel Cancer UK (2012) where younger patients reported being misdiagnosed with other conditions and had delays of up to six months to receive a diagnosis. However, other research has found that only 13% of patients who go on to receive a diagnosis of bowel cancer wait more than two months for a referral for diagnosis (Lyratzopoulos *et al.*, 2013).

Patient income domain also produced significant results, as patients reported a lower income, the likelihood of a more advanced or unknown cancer stage increased, with rrr's ranging from 1.065 when stage 1 and stage 2 were compared to 1.137 when stage 1 and stage unknown were compared in the analysis. Patient income domain was the only available measure from NYCRIS and has been used in this project as an indicator of patient

deprivation. Income domain quintile is a component of wider known measures of deprivation and socio-economic status, specifically the national measure of the IMD. There is a well-recognised link between cancer stage and deprivation, or socio-economic status, and the findings of this research support previous research (Iyen-Omofoman *et al.*, 2011, Parikh‐Patel *et al.*, 2006, Forrest *et al.*, 2014).

It had been expected to find an association between patients' sex and their cancer stage at diagnosis would be found, as previous research had found delays in female patients receiving a diagnosis and for being diagnosed with a more advanced or unknown stage of colorectal cancer compared with male patients (Lyratzopoulos *et al.*, 2012a, Doran *et al.*, 2014). In the case of the study conducted by Bowel Cancer UK (2012) this was a small survey (n = 109) of young people who had been diagnosed with bowel cancer and therefore it is difficult to compare the results. However, the study by Neal and Allgar (2005) used national data for six cancers, including bowel, with a total sample size of n = 65,192, which could be considered more comparable with this study where the sample size for bowel data was n = 11,606. The data for the Neal and Allgar study came from the National Survey of NHS Patients: Cancer (Boreham *et al.*, 2002, Department of Health, 2002) and the survey was conducted in 2000, compared with the data for this present study coming from 2006-2008. It could be that finding that sex did not prove to have a significant effect upon cancer stage at diagnosis, in the regression analysis of this present study, suggests that the inequality found by Neal and Allgar may have been due to chance, at least within the North East region of England.

No significant association was found between the QOF domain scores and total score with cancer stage. This was unexpected as colorectal cancer during the time period of the data did not have a screening programme in the North East of England and cases would have been diagnosed primarily through a symptomatic route via a patient's GP. Therefore,

it had been hypothesised that GP quality, as measured by QOF, would influence colorectal cancer stage.

Despite none of the QOF domains or total score showing an association, one of the specific practice variables from QOF did prove to be significant. 'A patient's ability to see a doctor within two days' is a variable from the patient experience domain of QOF, with an RRR of .2197. This shows that as a patient reports being unable to see a doctor within two days of asking for an appointment then the likelihood of them being diagnosed with an unknown colorectal cancer stage increases. This specific QOF indicator has previously been linked to emergency admissions for cancer (Kontopantelis *et al.*, 2010, Bottle *et al.*, 2012).

Following on from this, when the regression analysis was repeated with just the top and bottom 10% of practices, other specific variables became significant; the proportion of elderly patients within a practice and a patient's ability to speak with a GP via telephone. The association with age is well recognised (Iyen-Omofoman *et al.*, 2011, Rutherford *et al.*, 2013) and there is a range of previous research that has highlighted the variable of a patient's access to GP services as an influence upon a patient's cancer diagnosis and outcomes (Bain and Campbell, 2000, Campbell *et al.*, 2001, Launoy *et al.*, 1992, Parikh-Patel *et al.*, 2006, Stevenson *et al.*, 2003).

Following the multinomial regression analyses, a trend analysis was conducted on the individual QOF domains against patient colorectal cancer stage and it was found that the patient experience domain was significantly associated with colorectal cancer stage, further supporting the findings from the regression analysis. Previous research has identified that performance in the GP patient survey and the patient experience domain of QOF is strongly linked, and that both are linked to a practice's performance in achieving higher QOF scores, indicators, and aspects of patient experience, to be significantly

associated with patient outcomes for cancer (Kontopantelis *et al.*, 2010, Llanwarne *et al.*, 2013, Lyratzopoulos *et al.*, 2012b).

The multi-level analysis did not find any significant variance between breast cancer stage at the GP practice level. With few findings from the regression analysis this was unsurprising but as discussed previously it had been hypothesised and expected that GP quality would have an influence upon colorectal cancer stage at diagnosis, due to the nature of diagnostic pathways for colorectal cancer at this time.

6. 3. 2. Breast

The descriptive and distribution analyses found that the majority of patients had been diagnosed with less advanced stages of breast cancer; 80.92% had a diagnosis of stage 1 or 2 (Lyratzopoulos *et al.*, 2012a). This higher proportion of cancer cases being diagnosed at less advanced stages is an expected pattern in breast cancer. There is a national screening programme for breast cancer in England and the screening information obtained revealed that 35.61% of the breast cancer cases in the data were identified through screening which compares to the national average of 32% (Lawrence *et al.*, 2011). Of the screened cases 92.47% were diagnosed with stage 1 or 2 breast cancer.

The distribution between the two age categories was almost even, with patients of retirement age constituting 44.6% of the breast cancer data and 55.4% of the patients being of working age. The distribution of breast cancer stage and patient age was found to be significant, specifically that patients of retirement age had more advanced or unknown stage at diagnosis which supports previous research findings (Lyratzopoulos *et al.*, 2012a, Bastiaannet *et al.*, 2010, Cuthbertson *et al.*, 2009, Adams *et al.*, 2004a).

The correlation analysis provided a range of findings which were similar to the colorectal cancer data correlation analysis. Specifically breast cancer stage was found to

correlate with patient income domain; as a patient's income increases, the likelihood of more advanced breast cancer stage at diagnosis reduces and this finding supports previous research (Adams *et al.*, 2004b, Una *et al.*, 2000, Rutherford *et al.*, 2013).

Patient age was found to significantly correlate with breast cancer stage, but this time a patient's age was a positive correlation, whereby patients of retirement age were more likely to have a more advanced or unknown cancer stage at diagnosis compared to patients of working age (Boreham *et al.*, 2002, Cuthbertson *et al.*, 2009, Lyratzopoulos *et al.*, 2012a). Lyratzopoulos *et al.* (2012a) found patients aged >70 years to have a higher frequency of more advanced breast cancer stage at diagnosis and suggested that this could be linked to patient level of deprivation; those of low socio-economic status were more frequently diagnosed with a more advanced breast cancer stage. Cuthbertson *et al.* (2009) also suggested that this effect could be associated with the age restrictions on the national breast cancer screening programme. In England during this time period, the advised age range for screening was females aged 50-70. In females over the age of 70 only 7% of cases are screen detected, compared with the national average of 32% (Lawrence *et al.*, 2011).

Screening information for the breast cancer data was available and while this information was excluded from the later and more advanced analyses it was included in the initial and descriptive analyses. In the correlation analysis it was found that patients who had no information or were not diagnosed through a screening pathway were more likely to have a more advanced or unknown cancer stage at diagnosis. This finding fits with previous research that breast cancer screening identifies breast cancer at earlier and less advanced stages (Lawrence *et al.*, 2011).

In the regression analysis it was found that patient age had a significant association (RRR ranged from 2.424 to 5.461) with breast cancer stage, continuing the findings from the correlation analysis that patients of retirement age are more likely to be diagnosed

with a more advanced or unknown cancer stage. Within the practice profile there are specific variables related to elderly patients, specifically the percentage of patients within a practice who are over 75, the proportion of patients who are classed as elderly (65+), and the percentage of patients within the practice who are over 85. All three of these variables also produced a significant association between increased age and a greater likelihood of more advanced or unknown breast cancer stage. This is a trend that has been observed in previous cancer research and also within breast cancer specific research (Adams *et al.*, 2004a, Cimprich *et al.*, 2002, Cuthbertson *et al.*, 2009, Richardson *et al.*, 1992, Boreham *et al.*, 2002, Rutherford *et al.*, 2013, Lyratzopoulos *et al.*, 2012a, Bastiaannet *et al.*, 2010).

The findings surrounding the QOF domains and total score was of interest, with the domains producing an RRR of <1 while the total score was >1. This was an interesting finding as such results have not previously been reported. However, this specific and particular analysis had not been done previously. An explanation or suggestion has yet to be formulated, despite contact and conversation with members of the NHS information centre, it therefore appears to be an idiosyncratic result and finding.

A number of specific variables from the patient experience domain were found to be significant in the regression analysis, including opening hours of the practice and patients being able to see their preferred GP. Both of these variables are from the patient experience domain and these findings suggest that this may be a key area that contributes to patient cancer stage at diagnosis. This is a similar finding to data from the regression analysis of the colorectal data and previous research has found an association between patient experience and satisfaction and cancer outcomes (Llanwarne *et al.*, 2013, Kontopantelis *et al.*, 2010, Bottle *et al.*, 2012).

Specific variables from the QOF clinical domain were also found to be significant. Firstly, the cancer review variables, which is an indicator of whether a GP performs a

review of the cases within three months of diagnosis once a diagnosis has been made. This particular indicator has been highlighted as a problematic and questionable indicator within QOF. Adams *et al.* (2011) in their study reported that GP and primary care teams did not feel that the current cancer review format was helpful and that there was scope for improvement within this area. Equally the cancer charity, Macmillan developed an alternative cancer care review template which was trialled amongst a group of GPs and was found to be more useful and user friendly (Macmillan, 2012).

Secondly, the variable of cancer prevalence, which is the prevalence of cancer cases diagnosed within the practice population; specifically it was found that as the prevalence of cancer cases increases in a practice so does the likelihood of breast cancer cases being diagnosed with an unknown stage. This could suggest and direct towards previous research and findings such as the inverse care law, that practices which are dealing with a high volume of healthcare issues struggle to deal with demand and as a result the overall care and quality of that care is diminished (McLean *et al.*, 2006, Mercer and Watt, 2007, Watt, 2002).

When additional regression analyses were conducted with just the top and bottom 10% of practices, a number of other specific variables were found to have a significant association. These were; the practice opening hours, a patient's ability to see their preferred GP and a patient's ability to see a doctor within two days. All three of these variables are indicators from the patient experience domain of QOF, therefore further adding support to the findings of this and previous research (Bottle *et al.*, 2012), of the association between patient experience and cancer stage.

It should be noted that while a number of significant findings, between stage 1 and stage 4 and stage unknown and between stage 1 and stage 3 in the top and bottom decile analysis were found, there is a potential issue of power. From the distribution of cancer

stage, within the breast cancer dataset, there is a higher proportion of cases diagnosed at stage 1 and 2, a trend which remains even after screen detected cases are removed. This creates a potential argument for bias within the results as a smaller group of more advanced stage patients have been compared to a larger group of less advanced stage patients. However, this bias in numbers, as mentioned, is representative of the distribution in cancer stage within breast caner nationally, even if proportionally they are biased. Dichotimising cancer stage was a method used to try and reduce this bias, while still retaining a represenative sample.

The trend analysis, between cancer stage and the individual QOF domains and total score, did not identify any significant results. This was a surprising result as the QOF domains and total score had previously provided a significant correlation in the regression analysis.

In the multi-level analysis a relationship was found between GP practice quality and cancer stage at diagnosis. This was an unsurprising finding as the QOF domains and total score had been found to be significant in the regression analysis, along with a range of specific practice level variables. When this analysis was conducted with the top and bottom 10% of practices, the association between GP quality and breast cancer stage nearly doubled in the majority of the results.

As yet there is no research that has looked specifically at breast cancer stage at diagnosis and GP practice quality, as measured by QOF. Other measures of assessing quality have been used, such as referral rates for breast cancer and these have provided mixed results (Rubin *et al.*, 2011, Potter *et al.*, 2007, Cornford *et al.*, 2004). Time from presentation to receiving a diagnosis and survival outcomes for breast cancer are significantly better compared with other cancer types (Baughan *et al.*, 2009, Allemani *et al.*, 2010, Coleman *et al.*, 2003, Møller *et al.*, 2009, Thomson and Forman, 2009). However,

the findings from this project highlight that there is still room for improvement and indicate that GPs contribute significantly to this area.

6. 4. Interpretation of results in wider context

The key finding of this research was the evidence of a significant link between GP practice quality and patient cancer stage. While this was more clearly demonstrated and found in the breast cancer dataset, there were findings in the colorectal cancer dataset that demonstrated a significant relationship between aspects of GP practice quality and patient cancer stage. The combination of different analyses meant that it was possible to uncover these more specific variables that related to GP practices and their provision of quality. Specifically in both breast and colorectal cancer many of these specific variables were from the patient experience domain of QOF; in breast cancer, additional variables from the clinical domain were also significant.

It could be suggested that in the breast cancer findings, the significant specific variables from the regression analysis are the key contributors on the variance in quality observed in the multi-level model. If so this suggests that patient experience at a primary care level is key to practice quality and increasing the likelihood of patients being diagnosed with a less advanced breast cancer stage.

Patient experience and satisfaction is a well-recognised component of primary healthcare. Since the late 1980s, Howie (Howie *et al.*, 1997, Howie *et al.*, 2004, Howie *et al.*, 1989, Howie *et al.*, 1991, Howie *et al.*, 1999) has researched the impact of GP consultations and their length on patient satisfaction and outcomes and highlighted continually the importance of a patient leaving a consultation feeling understood, able to cope with their symptoms and satisfied. Recent research by Llanwarne *et al.* (2013)

examined the relationship between QOF and GP patient survey data to see if there was a relationship between clinical quality and patient experience. While associations were found and the strongest associations were found between quality of care and access which supports the findings of this research, it was also highlighted that aspects such as the quality of interpersonal care should be considered separately. This again demostrates that while a greater understanding is being gained; patient experience and the provision of primary care are still complex areas which can be influenced by a range of factors.

Previous research has identified a range of factors which can affect GPs' decisions regarding potential cancer cases, such as: a GP's sex (Robertson *et al.*, 2004), whether the GP works full or part time (Parkerton *et al.*, 2003), the size of the practice (Hippisley-Cox *et al.*, 1997, Wang *et al.*, 2006), the number of previous consultations (Lyratzopoulos *et al.*, 2012a), co-morbidity (Jiwa *et al.*, 2004), and a GP's training (Pockney *et al.*, 2009, Wade *et al.*, 2010).

GPs are often considered to be 'gatekeepers' between primary and secondary care, and it has been suggested that this role within a healthcare system can have a negative effect upon patient cancer outcomes (Vedsted and Olesen, 2011). However, in other countries that have GPs as 'gatekeepers' cancer outcomes do not appear to be affected by this form of healthcare structure and it is instead suggested that there are other organisational and resource factors that are a greater influence upon cancer outcomes (Brown *et al.*, 2014, Rubin *et al.*, 2011). It could, therefore, be suggested that the variance and significant factors observed in this study are not associated with the GPs and practice characteristics but instead some other unaccounted for factor and influence. While the total score of the organisational domain of QOF was included in the analysis perhaps the inclusion of individual QOF items from this domain could be included in future research.

A patient's psychological and individual factors can also contribute to their own experience and consultation with a GP. It is well-recognised that many patients delay before presenting symptoms to their GP (de Nooijer *et al.*, 2001, Macdonald *et al.*, 2006, Neal *et al.*, 2008b, Tromp *et al.*, 2005, Pitiphat *et al.*, 2002), and this can be for a range of reasons from simple time constraints (Shack *et al.*, 2008) to personal beliefs such as feeling undeserving of healthcare action (Corner *et al.*, 2006).

Geographical influences have also been found to affect patient access to primary care services and ultimately in some cases, patient cancer outcomes. Patients who live in rural areas tend to be diagnosed with a more advanced cancer stage at diagnosis and report more problems accessing services (Bain and Campbell, 2000, Campbell *et al.*, 2001, Launoy *et al.*, 1992, Liff *et al.*, 1991, Parikh-Patel *et al.*, 2006, Lovett *et al.*, 2002, Pitchforth *et al.*, 2002, Jones *et al.*, 2008, Goddard *et al.*, 2010, Baird and Wright, 2006). However, research has also suggested the opposite effect, in that close proximity to a cancer centre is associated with delays in diagnosis and treatment (Robertson *et al.*, 2004, Tørring *et al.*, 2013).

The issue of access is an important component of patient experience and satisfaction, not just in terms of geography and being able to travel to a GP or primary care provider, but there is also a growing issue regarding access to these services. Specifically many of the points from the GP patient survey, which are used as indicators by QOF, are related to being able to access a GP by means of an appointment or phone consultation. Llanwarne et al (2013) recently supported this concept in their investigation into the association between QOF and patient experience, finding that aspects of the GP patient survey related to access had the strongest correlation with clinical score from QOF.

Research that has utilised data from the GP patient survey has found that overall, patients report being satisfied and report positive experiences of primary care (Bottle *et al.*,

2008, Lyratzopoulos *et al.*, 2012b). Participation in the GP patient survey, like QOF, is voluntary and Nagraj *et al.* (2013) conducted a study to look at the disenrollment rates of GP practices from the scheme. They found that GPs who had dropped out were most likely to be from practices which had received low scores, however there was still substantial drop out from practices with higher scores.

Patient income domain was used in this project as a measure of deprivation. Income domain is used along with other indicators to create the IMD, a wider and national measure of deprivation and socio-economic status. It was a significant finding in this project for both breast and colorectal cancer that patients with a low level income were more likely to be diagnosed with a more advanced breast or colorectal cancer stage. Patient deprivation has been previously linked with more advanced cancer stage, but it has also been significantly linked with reduced and problematic access to primary care services, with GP practices located in deprived areas showing worse health outcomes and higher rates on ill health (Forrest *et al.*, 2014, Una *et al.*, 2000, Macdonald *et al.*, 2006, Kontopantelis *et al.*, 2010, Baird and Wright, 2006, McLean *et al.*, 2006, Rutherford *et al.*, 2013, Strong *et al.*, 2006, Wright *et al.*, 2006). It could therefore be suggested that variables related to deprivation such as income domain are related and contribute to patient satisfaction and that was found in the correlation analysis of the variables in both breast and colorectal cancer ($p > .05$ between patient experience domain and patient income domain, practice deprivation level and IDAOPI). This finding is supported by previous research which has examined the link between GP practice performance and socio-economic status (Richardson *et al.*, 1992, Wang *et al.*, 2006).

Research in other disease areas has highlighted similar findings and issues. Levene *et al.* (2010) conducted a cross-sectional national study of patient factors affecting coronary heart disease mortality and found variation in mortality across the country to be

significantly associated with patient factors, such as socioeconomic status and ethnicity, while measures of clinical performance and practice quality were not signifcant. Bottle *et al.* (2008) reflected this in their earlier study which suggested improvements in primary care quality would not equate to improved outcomes and reduced secondary care burdens.

Looking at the influence of GP quality on cancer stage at diagnosis and using cancer stage at diagnosis as the outcome measure against QOF and practice profile data as a measure of GP quality is a novel approach which has not been used previously. As a contrast, GP referrals have previously been used as a measure for primary care cancer outcomes and quality and similar results have been found (Haikel *et al.*, 2011, Neal *et al.*, 2008b, Potter *et al.*, 2007, Neal *et al.*, 2007, Kirwan *et al.*, 2002).

Foot *et al.* (2011) conducted an inquiry, for the King's fund, into the quality of GP diagnosis and referrals. This national review studied variables and factors that influence referral rates, finding that while there is a large body of research in this area, the findings are inconsistent. There is evidence that GPs have a substantial influence on referral rates, but what specific GP factors and variables cause that relationship are unclear and any suggestions were found to be wide ranging, see table 19 below. The findings of this study echo this, that GPs clearly have a significant influence upon patient cancer diagnosis, in particular patient experience is a key component of this, but an explanation as to how this influence works is not yet clear.

Table 19. Factors associated with referral rate, taken from Foot *et al.* (2010).

GP or practice factors	Patient factors	Structural factors
GP beliefs or expectations about benefits of referral	Severity of symptoms	Distance to specialist service
GP age or experience	Desire for referral	Area deprivation
GP gender	Age	Availability or accessibility of specialist care
Degree of training in relevant specialty	Gender	Availability of community alternatives to specialist care
GP–patient relationship, congruence between GP's and patient's attitudes	Social class	Time available for consultation
GP relationship with specialist	Diagnosis	
Practice size	Co-morbidities	
Fund-holding history	Help-seeking behaviour	
Services available in practice	Perception of the problem	
GP psychological characteristics – for example, ability to tolerate uncertainty, concern that non-referral might damage patient relationships	Attitudes towards treatment	

6. 5. Strengths of the study

Selecting just two cancer types and using data from the Northern and Yorkshire region of England was of benefit for a range of reasons. Initially it provided focus for the project and these limits also aided in maintaining an achievable time scale for this study, as too broad a focus and a larger amount of data would have significantly increased the required time scale.

Working with just one cancer registry was also of benefit as they were able to advise and recommend cancers to focus upon in addition to advising on questions regarding ethics. As a result, breast and colorectal cancer were selected as they had the highest completeness rate within NYCRIS, but are also two of the most common cancers within the UK and as such are a high priority for research. Using data from just the Northern and Yorkshire regions of England also became a strength, as geographical differences between regions have been observed in previous research especially between Northern and Southern regions (Walters *et al.*, 2011, Goddard *et al.*, 2010, Bambra and Popham, 2010). Therefore, narrowing the focus of the study by selecting breast and colorectal cancer with northern regions of England, not only made this study achievable within the time constraints but the impact of this research was also increased.

Prior to any analyses taking place a number of ethics applications had to be made. Due to the nature of the research and the possibility of potentially identifiable patient data being used, the NIGB were consulted. At the point at which ethics applications were being made for this study, the NHS REC and NIGB had not dealt with this specific data combination approach and a number of discussions regarding methodology and treatment of data were held with the NIGB. This meant that for ethical approval, this study and its methodology was reviewed by three distinct organisations, NIGB, NHS REC, and University

ethics, and granted approval. This is a rigorous process and a strength of the study which benefited both from having been reviewed by and having had the input of a number of external organisations and institutions.

While the national colorectal screening programme had not fully taken effect for the time period of data used in this study (2008-2008) the national breast screening programme was in effect. NYCRIS collects information regarding cancer cases identified through screening and was able to provide this data so that cases within the breast cancer dataset that were screen detected, could be excluded. This accounted for 35.6% of the breast cancer cases which were then excluded reducing any potential skewing of the analysis and results.

While some preparation of the NYCRIS data was required, one of the benefits of using the data from the practice profiles and QOF was that it is made publically available and the data has already been prepared and searched for errors.

The range of analyses used were also a strength of the study as it created the opportunity to look at the specific, as well as the overall effects of a wide range and number of variables. Separating key variables, such as patient demographics and the QOF domains and total scores and analysing them against breast and colorectal cancer stage provided a more in-depth understanding of the data. It also provided the opportunity to test well recognised associations, such as the effect of age upon cancer stage. Conducting a multi-level analysis gave an overall view of whether GP practice quality was associated with patient cancer stage, while also conducting a regression analysis provided details about which specific variables were significantly associated. For example, while colorectal cancer stage was found in the multi-level analysis to not be significantly affected by GP practice quality, it was found in the regression analysis that variables from the patient experience domain of QOF did have a significant affect upon patient cancer stage.

6. 6. Limitations of the study

QOF is a national and government backed quality scheme and while the use of such a large healthcare dataset can be seen as a strength of the study, QOF does have its limitations. Previous research has criticised the validity of QOF and questioned whether it is an effective measure of quality (Steel and Willems, 2010, de Wet *et al.*, 2012, Downing *et al.*, 2007b, Short, 2007). In terms of disease indicators and specifically those related to cancer, QOF is limited, in fact at the time of this project there were only three points within QOF which were cancer specific (Downing *et al.*, 2007b, Office of National Statistics, 2012). In previous research it is also well documented that QOF has a positive bias, with the majority of practices scoring highly and this was reflected in the descriptive analysis of this project. While dividing the practices into deciles and using just the top and bottom practices to try and account for this positive bias was a solution that has previously been used (Wilson *et al.*, 2010, Møller *et al.*, 2012), it is not possible to remove the bias completely. Even the lower performing practices achieve over 80% of the total available QOF points, therefore there remains a small difference between the highest and lowest performing practices. This small level of variation could potentially explain some of the negative and non-significant results, in that variation in GP practices was found to not have an affect upon the cancer stage of a patient simply because there was no variation in the GP practices. However, this suggestion had been the motivation for exploring and using the methodology of comparing top and bottom deciles practices to provide a potentially more suitable sample for comparison. A suggestion would be to use an alternative measure of primary care quality but, as previously discussed, at the time of this research QOF was the most comprehensive and national measure of primary care quality available.

While breast and colorectal cancer were identified as common cancers, the number of cancers that had a good completeness rate of cancer stage at diagnosis was limited. The

consideration at the start of this project had been to include at least three of the most common and priority cancer types for analysis, of which breast and colorectal are two, but also other cancer types such as lung. Lung cancer was of particular interest due to its poor survival rate, particularly in comparison to other common cancers like breast and colorectal (Holmberg *et al.*, 2010, Neal *et al.*, 2007, Thomson and Forman, 2009, Verdecchia *et al.*, 2007a). Upon consultation with NYCRIS it was discovered that cancer types such as lung had very low recording rates for cancer stage, less than 10%. However, despite being one of the better recorded cancer types, of the colorectal data received from NYCRIS, nearly 50% of the cases were assigned an unknown stage of colorectal cancer, but this is in line with national statistics.

An alternative to using data from NYCRIS may have been to use data from another cancer registry or an alternative data source, such as the General Practice Records Database (GPRD). The GPRD has been widely used within research (Wood and Martinez, 2004, Glaser *et al.*, 2013, Rachet *et al.*, 2010, Hwang *et al.*, 2009), but for this particular project it would have raised issues of access, specifically a longer ethics process. The GPRD is also not disease specific and the cancer registries obtain their data from a range of healthcare resources, including the GPRD, so hold better and more detailed data that was of benefit to this project.

Working with the data, once it was received, was a process which took longer than anticipated. Specifically, the data cleaning took longer than hoped as there were a range of small problems including errors in the data, missing and incomplete information, finding a method to merge the different databases, and formatting and software issues. For example, Stata is widely used within healthcare research but is not used by the NHS, so data which was received from NYCRIS and ERPHO, had to be converted. Efforts were made to keep the analysis straightforward so as not to over-manipulate the data; for the analysis

this meant separating the data on occasion and running a number of individual tests, which took more time. In essence there were a number of small and wide ranging issues which arose while working with the data which caused delays and meant the process took longer than anticipated.

In the case of the analysis of the colorectal dataset there was a lack of significant results for which a possible explanation may be found in the design of the study.

While a large number of practices were included in this analysis, a number were excluded as part of the ethical process due to small numbers. The excluded practices had seen less than five cases of colorectal cancer in a three year period and as such they were likely to be a small or single-handed practice. Equally if a practice does not participate in QOF or has a small list size it is excluded from QOF and these practices were also removed from the analysis. The practices that remained in the analysis could, therefore, be considered biased, as they do not capture the full range of practice types within the geographical areas studied. Previous research has suggested that in some cases these small and single-handed practices are likely to be located in areas of high deprivation, areas with a transient population, and in areas where disease incidence and co-morbidity is high (Wang *et al*., 2006, Campbell *et al*., 2001, Saxena *et al.*, 2007). However, equally within these studies the quality of care provided by small and single-handed practices is not dissimilar to that of larger practices, for example, in Wang *et al.* (2006) they found smaller practices scored fewer QOF points but this was primarily within the prganisational domain of QOF, not clinical care.

Attempting to address this problem was part of the rationale for repeating the analysis with just the top and bottom decile based on QOF scores, to try and gain a better perspective on the range of practice performance. Again, however, in doing this the

number of patient cases and practices included in the analysis was further reduced, from 11,491 colorectal cases to just 2,340.

7. Chapter 7 – Conclusions

This concluding chapter presents the key findings of this thesis, followed by a reflection and critique of the strengths and limitations of the project as a whole. From this, suggestions for directions and improvements for future work in this area of research are made. In light of the findings and conclusion of this thesis, recommendations for future health and primary care policy are made, before a final summary of this project is presented.

7. 1. Key findings

The key findings of this project were as follows:

- From the systematic review there was found to be a lack in research that had investigated primary care quality and its impact upon cancer diagnosis. Previous research was also found to rely on self-reporting questionnaires from GPs regarding their adherence to guidelines, identifying a lack of research that had effectively utilised existing healthcare databases and sources.
- An association between GP practice quality and breast cancer was found in the multi-level analysis, with GP quality accounting for between 12 – 18% of the variance between breast cancer stage. No variance, less than .01%, was found between GP practice quality and colorectal cancer stage.
- A number of significant associations were found between both breast and colorectal cancer stages and specific GP practice indicators, most notably indicators associated with patient experience and satisfaction such as; patients' reported ability to see a doctor within two days and opening hours of the practice.
- Well recognised associations between cancer stage and the patient variables of age and income domain, were also found to be significant in both breast and colorectal cancer. Specifically in breast cancer, older patients and those with a lower income were more likely to be diagnosed with a more advanced stage of breast cancer. Colorectal patients who are younger and have a lower income are more likely to be diagnosed with a more advanced stage of colorectal cancer.

7. 2. Strengths of the project

Conducting a systematic narrative review prior to the analysis was beneficial as it provided a more rigorous rationale for the study but also aided in informing and directing the methodology. For example, the findings that only a small number (n = 2) of papers had utilised QOF in their research highlighted the need for research in that area, but also lent support to the objective to utilise existing healthcare databases. The methodology of the systematic review, such as the hand searching of reference sections for additional papers, the use of more than one database and the use of a second reviewer within the systematic review all helped to ensure papers were not missed and also reduced researcher bias and provided an outside/second opinion.

Using data from just the Northern and Yorkshire region of England also became a strength, as geographical differences between regions has been observed in previous research especially between Northern and Southern regions (Walters *et al.*, 2011, Goddard *et al.*, 2010, Bambra and Popham, 2010).

Selecting just two cancer types was a strength of this project for a number of reasons. Firstly it provided focus for the project. Breast and colorectal cancer are two of the most common cancers within the UK and as such are a high priority for research, therefore, by selecting breast and colorectal cancer it also increases the impact of this research. It would have made it difficult to complete the project in the timescale if other or all cancer types had been included.

Breast and colorectal cancer differ in a number of ways, from the profile of patients they affect, symptomology, diagnostic pathways etc. (Jiwa *et al.*, 2008, Cornford *et al.*, 2004, Bekkink *et al.*, 2010, Cancer Research UK, 2013). Focusing on just two differing

cancer types provided the opportunity to explore and analyse whether GP practice quality affected breast and colorectal cancer in different way.

From the perspective of data quality and analysis, focusing on two of the most common cancers ensured a good sample size for this project. Out of the most common cancers, NYCRIS had the best reporting rates for breast and colorectal cancer, which was essential as cancer stage at diagnosis was being used as the outcome measure for this project. In the case of breast cancer, NYCRIS held information regarding screen detected cases, which meant screen detected cases which have no or little GP involvement in presentation and diagnosis, could be excluded and reduce skewing the analysis and results.

With the data that was received from NYCRIS, the process of data cleaning identified common areas where errors occurred. A procedure was developed to find and identify missing information and using this procedure 1,437 cases with fields of missing or incorrect data were found and the correct information was given to NYCRIS. The procedure used was also disseminated back to NYCRIS. Conversely, data from the practice profiles and QOF is publically available and has therefore already been prepared and checked for errors.

The use of secondary data analysis and existing databases in health research is becoming more common (Adams *et al.*, 2004b, Downing *et al.*, 2007b, de Wet *et al.*, 2012, Ivbijaro *et al.*, 2008, All Party Parliamentary Group on Cancer, 2009, Holmberg *et al.*, 2010, Lyratzopoulos *et al.*, 2013, Llanwarne *et al.*, 2013). The practice profiles were only created and made publicly available in late 2010, during the second year of this project and since then cancer specific practice profiles have also been created and made available in December 2012. At the point at which the ethics application was being made for this research the NHS REC and NIGB had not dealt with this specific data combination approach. That this research required working with the NIGB on ethical issues I believe is a strength as

it meant and demonstrated that the research had a new and novel approach and also underwent close and considered scrutiny.

The range of analyses used were also a strength of the study as it created the opportunity to look at the specific, as well as the overall effects of a wide range and number of variables. For example, while colorectal cancer stage was found in the multi-level analysis to not be significantly affected by GP practice quality, it was found in the regression analysis that variables from the patient experience domain of QOF did have a significant affect upon patient cancer stage. In the breast cancer dataset the incorporation of additional analysis with all patients of screening age (50-70 years) excluded was another strength of the research as it ensured that potential for confounding by variation of screening uptake and any screening/Hawthorne effect that may occur within a practice was accounted for.

I believe an overall strength of this project has been the continued input of individuals, organisations and institutions external to this project, which has meant that this project has been continually reviewed throughout each stage. This has included a second reviewer for the systematic review, contact regarding ethics and ethical approval from the NIGB, NHS REC, and Durham University ethics, guidance from statisticians within Durham University, opportunities to discuss issues with other health researchers within FUSE (The Centre for Translational Research in Public Health), and annual reviews of the project by Durham University School of Medicine and Health.

7. 3. Limitations of the project

The systematic narrative review which was conducted prior to analysis had some limitations. While two databases were used and searched there was overlap between the search results, due to both databases specialising in medical and biomedical studies, therefore, the inclusion of an additional database(s), such as PubMed, may have been of benefit and produced additional papers which may have been missed. While a more rigorous review, such as a meta-analysis, would have been the aim it was not possible to conduct because of the varied methodologies and outcome measures of the papers included. This in itself became a strength and finding of the review regarding the inconsistent approach to quality of primary cancer care research.

While the use of a national scheme and database such as QOF can be viewed as a strength, particularly in light of the systematic review highlighting the lack of research that had utilised QOF as a research resource, QOF does have its weaknesses. These have been previously discussed, such as criticisms of validity (Steel and Willems, 2010, de Wet *et al.*, 2012, Downing *et al.*, 2007b, Short, 2007), and limitations of cancer specific items (Downing *et al.*, 2007b, Office of National Statistics, 2012). Since this research was undertaken, in line with the move from research councils like the ESRC to utilise large datasets and secondary analysis, there has been an increase in research projects of this type. As such a greater understanding of the limitations and considerations that must be undertaken when using large datasets such as QOF have been indentified. Specifically Saunders and Abel (2014) reviewed this issue in a publication earlier this year that provides an outline on the considerations around the design of large ecological studies which use varied outcome measures, and certainly any future research in this area should follow this guidance.

There are a number of considerations around study design which while they can be considered and discussed it was simply not practical or feasible to carry these out. For example, in their article Saunders & Abel (2014) highlighted the issue of comparing individual data against aggregated group data. Ideally instead of using totals and averages from the GP survey for a practice, linking individual patient's cancer data and outcomes with a patient's individual response to a GP patient survey would be the best option. However, GP patient surveys are not completed by all patients, only a selective number of surveys are sent out to patients, and equally it would be difficult to gain permissions for that particular level of indivudal patient data from NHS and ethics organisations.

Within this study there were also a large number of variables which were included in the analysis, because of this there was the potential that a type one error may occur and signifcant results may be the result of chance rather than an observable effect. This was a concern for the study design and findings regarding this multiple testing and while steps were taken to reduce the risk of this issue of multiple testing it was not possible, and therefore remains a limitation, to eliminate the problem altogether.

In the multi-nomial regression analyses there were 7 patient and 18 GP variables, and this analysis was being conducted multiple times, therefore, at least one of the signifcant findings could be assumed to be signifcant by chance. Measures of fit were investigated, for multinomial regression in Stata it is recommended (Institute for digital research and education, no date) to refer to the 'prob > chi2' and 'pseudo R2', these were all <0.05 with the exception of the regression analysis for colorectal cancer with just the top and bottom decile included in the analysis. The repetition of analyses with just the top and bottom deciles of GP practices also provided a sense check of sorts. While some variables did change in significance the majoirty of findings from the larger analyses remained in the refined analyses, which suggests the findings are not simply by chance. Equally once intial

analyses were conducted reduced variable models, where variables with no correlation were removed and analyses were conducted again, showed that signifcant results remained. There is still a risk that the same signifcant results are coming up time and again by chance, but it is not possible to eliminate all type one error, however the repition of analyses using specific sample groups and reduced variable models does provide an opportunity to observe changes in signifcant findings.

Breast and colorectal cancer were good cancer types to focus on for this project, but the availability of cancers with a good completeness rate of cancer stage at diagnosis was a problem. The consideration at the start of this project had been to include at least three of the most common and priority cancer types for analysis, of which breast and colorectal are two, but also other cancer types such as lung. However, upon consultation with NYCRIS it was discovered that cancer types such as lung had very low recording rates for cancer stage, less than 10%, while breast and colorectal had some of the highest rates.

Despite being one of the better recorded cancer types, the colorectal data received from NYCRIS had nearly 50% of the cases assigned to an unknown stage of colorectal cancer. However, this is in line with national statistics.

An alternative may have been to use data from another cancer registry, but NYCRIS is one of the leading cancer registries for colorectal cancer and has the highest rate of completeness for colorectal cancer data. Another alternative to using cancer registry data would have been to use the General Practice Records Database (GPRD), and this database has been widely used within research (Wood and Martinez, 2004, Glaser *et al.*, 2013, Rachet *et al.*, 2010, Hwang *et al.*, 2009). For this particular project using the GPRD would have raised issues of access, specifically a longer ethics process. The GPRD is not disease specific, while the cancer registries are, and the cancer registries obtain their data from a

range of healthcare resources, including the GPRD, so hold better and more detailed data that was of benefit to this project.

My own experience and knowledge was a limitation for this project, particularly in the beginning. While I had experience of research and conducting a large scale study, I had not previously studied or worked within the area of NHS and healthcare research. Specifically, I had no previous experience of NHS or NIGB ethic procedures and this was a large part of the early stages of the project, taking a total of nine months.

For the data management and analysis it was recommended to use the statistical software package Stata. This was not a statistical software package I had prior experience of using and therefore it required me to spend time learning, attend workshops, and simple trial and error on how the software worked, which took time. I had also not used multi-level modelling as an analysis method before, which again required attending workshops, seeking help from statisticians and trial and error.

Working with the data once I had received it was also a process which took longer than anticipated. Specifically data cleaning, for which there was a range of small problems from; errors in the data, missing and incomplete information, finding a method to merge the different databases and formatting and software issues. For example, Stata is widely used within healthcare research but is not used by the NHS, so data that was received from NYCRIS and ERPHO had to be converted. Efforts were made to keep the analysis straightforward and not over-manipulate the data; for the analysis this meant separating the data on occasion and running a number of individual tests, which took more time. In essence there were a number of small and wide ranging issues which arose while working with the data which caused delays and meant the process took longer than anticipated.

7. 4. Suggestions for future research and policy

There are two key primary directions that future research in this area should take. The first would be to include more cancer types. What this project has demonstrated is that the level of influence that GP quality has upon a patient's cancer stage, varied. It has been established in previous research that the diagnosis, treatment and outcomes of different cancer types can vary widely (Allgar and Neal, 2005a, Baughan *et al.*, 2009, de Nooijer *et al.*, 2001, Rubin *et al.*, 2011, Jones *et al.*, 2009, Jones *et al.*, 2007, Cancer Research UK, 2013), which is why with over 200 different cancer types, understanding which cancer types are currently most, or least, influenced by GP quality is of importance for guiding and informing future policy and research.

With this in mind the addition and/or inclusion of more cancer types, such as the other most common cancers of prostate, lung and skin, would be of benefit. In this project while there were some similar results between breast and colorectal cancer there were also some distinct findings for both cancers. Therefore, exploring what other cancer types are, or are not, associated with GP practice quality would be of benefit to identify cancer types which perhaps need to be prioritised at that level.

Breast and colorectal cancer should also be included in any future research as they continue to be two of the most common cancers but also there is now more up-to-date data available for these two cancers, compared to time range of data used for this project. In particular a screening programme has since been introduced for colorectal cancer and new guidelines for the diagnosis and treatment of colorectal cancer have been introduced (Macmillan, 2012, Chew-Graham *et al.*, 2013).

The second key direction is the extension of the geographical area to include data from other cancer registries and/or national data. This project was only conducted with data

from the North East region of England and its findings may differ in other regions of the country.

Each region of England presents different geographical issues and these mean that different regions often face different challenges (Department of Health, 2013, National Cancer Intelligence Network, 2014, Walters *et al.*, 2011, Rabe-Hesketh and Skrondal, 2012, Institute for digital research and education, nd, Goddard *et al.*, 2010) and in particular it has been previously identified that there is a continued and clear North/South divide (Walters *et al.*, 2011, Goddard *et al.*, 2010, Whitehead and Doran, 2011, Rachet *et al.*, 2010). Therefore, conducting this research in different geographies would not only provide the opportunity to investigate geography as a factor in the association between GP practice quality and cancer stage, but also enable more accurate and tailored findings for each region of the country.

This project has demonstrated that multiple healthcare data sources can successfully be brought together, combined and analysed in a variety of ways. As outlined by the ESRC, it was one of the key aims and compulsory aspects of this project to utilise and combine existing sources of healthcare data. While this was a novel approach at the start of this project, there is a growing interest and momentum within health research towards using and creating combined healthcare databases and secondary data analysis.

Since the start of this project in 2009, other healthcare data has become available. Most notably the NCIN has produced GP practice cancer profiles, which first became available in 2012, and databases such as QOF and NYCRIS have been updated. In the case of NYCRIS, cancer registries in England still operate on a regional level but the data from each registry is now collated in a central register, ENCORE, which enables registration staff to collate further information with reference to staging, such as pathology reports, imaging data etc. There have also been recent developments within the overall management of

NHS data, with the introduction in 2013 of the General Practice Extraction Service (GPES). The GPES is now responsible for centrally managing and collating primary care data in England, including QOF.

The key benefit of both of these initiatives is that regional data is now centrally held and national data is therefore available from one source. For example, prior to ENCORE, acquiring national data would have required seeking approval and requesting the information from each of the regional cancer registries. As a result future research should look to utilise these collated databases, and in the case of furthering this research, look to replicate this project with national level data.

While there are national surveys of patient satisfaction and experience of primary care, GP practices do also conduct their own local and practice surveys of patient satisfaction. As the area of patient experience and satisfaction was a key finding from this project, the inclusion of more and wider ranging patient survey data would be of benefit in future research.

With the range of results in both breast and colorectal cases that demonstrated significant associations between the patient experience domain and specific QOF indicators from the patient experience domain, with cancer stage at diagnosis, it is suggested that the area of patient experience should be a focus of future research and policy. GPs and primary care providers have been identified as key in not just providing access to secondary healthcare and specialist services but actively contributing to improving early cancer diagnosis, outcomes and prevention (Richards, 2009, Daly and Collins, 2007, Thomson and Forman, 2009, Allgar and Neal, 2005b, Barrett *et al.*, 2010). Indicators from the patient experience domain of QOF are centred on access to GP services and this is an area that has been highlighted as a barrier to early diagnosis and future health outcomes (Daly and

Collins, 2007, Una *et al.*, 2000, Hippisley-Cox *et al.*, 2001, Robertson *et al.*, 2004, Stevenson *et al.*, 2003).

The inclusion of further details regarding GP practices' characteristics may also be a consideration for future research, as previous research has found an association between GP characteristics, such as; GPs' qualifications (United Nations, 2007) and practice size (Walters *et al.*, 2011), with the quality outcomes of the practice and patient experience and satisfaction.

A growing focus on patient experience and satisfaction has already begun, both within research and healthcare organisations, and this project supports that direction of focus. The findings of this project found that indicators of patient experience and satisfaction had a significant effect upon cancer stage in both breast and colorectal cancer. Many of these indicators related to a patient's access to their GP, such as their reported ability to see a doctor within two days and the opening hours of the practice, and previous research has produced similar findings. Therefore, in terms of policy it would seem that working towards improving a patient's access to GP services and GPs' relationships with patients to improve satisfaction should be a priority for healthcare policy.

There are also a number of theoretical and methodological concepts that are acknowledged and discussed in this thesis, that future research should look to address and incorporate. In particular the issues highlighted by Saunders and Abel (2014) regarding the generalisation of group/practice level data means that consideration about the use of alternative data to QOF is an implication for future research.

The data that has been used in this research has moved forward signifcantly, not just improvements within QOF but equally a wider range of data resources are also now available. In particular the development by the National Cancer Intelligence Network

(2014) of GP practice cancer profiles provides a more cancer specific alterntive to use as a measure of practice quality compared to QOF. These profiles annually collect cancer specific data from GP practices and contain and provide details related to waiting times and screening which could be incorporated with the cancer registry data as outcome measure alongside cancer stage at diagnosis. However, while these profiles are publically available they are again practice level measures of primary care quality where individual patient level data would be the best option.

There is now a cancer specific national patient survey (Quality Health NHS England, 2013), which while mainly focusing on treatment and longer term care provides data collected with regards to diagnosis and GP/patient interaction. The national cancer patient survey also collects a range of demographic patient information which is not included in QOF, such as patients' ethnicty, sexual orientation, employment status and the presence of other long term conditions. Again broadening this research to incorpate this data provides cancer specific data, but again this is at an aggregated group level where individual patient level data would be preferable.

7. 5. Summary of the project

The aim of this project was to investigate the potential link between GP practice quality and cancer stage at diagnosis, in breast and colorectal cancer in the North East of England. The objective was to achieve this by obtaining data from existing healthcare sources and databases and explore the potential link by using regression and multi-level analysis methods. This project was funded by the ESRC as part of an e-health infrastructure initiative, in collaboration with the NIHR, to use and combine existing healthcare datasets for secondary data analysis.

Once ethical approval was gained from the NIGB, NHS research and ethics committee and Durham University School of medicine and health ethics committee, patient data was obtained from NYCRIS regarding breast and colorectal cancer cases between 2006-2008, and GP practice data was obtained from ERPHO and the NHS information centre. All data was checked for errors before being converted and merged into Stata, with one dataset for colorectal cancer and the other for breast cancer.

The two datasets were analysed separately using Stata and a range of statistical analyses; descriptive and distributional analyses, chi-squared test, correlation matrixes, regression analysis and multi-level analysis. From the analysis the results were that while GP practice quality was found to contribute almost no variance for cancer stage at diagnosis in colorectal cancer, an association was found between breast cancer stage and GP practice quality. From the regression analysis, specific practice indicators from the patient experience domain of QOF were found to have a significant impact on cancer stage in both breast and colorectal cancer. Associations between cancer stage and patient age and income domain were also found in both breast and colorectal cancer.

This project was successful in meeting its aims and objectives. Different datasets were combined and analysed to find an association between GP practice quality and breast cancer and while a similar association was not found with colorectal cancer specific GP practice variables such as patient experience were found to have a significant affect upon cancer stage.

It is hoped these findings can be used to direct and prompt future research and policy. It is suggested that this research could be expanded to include other cancer types and geographical regions of England and that further investigation into the effect and influence of patient experience and satisfaction on cancer stage would be particularly recommended for future policy research. Since this project was started the datasets used have also been

improved and updated, and new sources of data, i.e. cancer practice profiles, ENCORE and GPES, have been created and made available. This project has demonstrated that such datasets can successfully be combined and analysed and it is hoped that future research will utilise these new and existing datasets.

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9. Appendix

Appendix 1. Ethical approval letter from NHS REC

Sunderland Research Ethics Committee

Room 002

TEDCO Business Centre

Viking Business Park

Jarrow

Tyne & Wear

NE32 3DT

Telephone: 0191 428 3566

Facsimile: 0191 428 3432

07 January 2011

Ms. Helen Wareham

Wolfson Research Institute

Durham University, Queen's Campus

Stockton on Tees

TS17 6BH

Dear Ms. Wareham

Full title of study: **Does good practice quality equate to earlier cancer stage at diagnosis?**

REC reference number: **11/H0904/4**

The Proportionate Review Sub Committee of the Sunderland Research Ethics Committee reviewed the above application on 14 January 2011 via email correspondence.

Ethical Opinion

The Committee's main concern was that insufficient detail was given on the way data is to be processed before regression analysis and therefore it is not clear how the research question will be answered.

The name of a statistician is given but not details of the way data will be processed. More information was requested on the way data is to be processed before regression analysis.

The cancer stages of patients when they are referred for breast colorectal and lung cancer are to be extracted from the Northern and Yorkshire Cancer Registry and Information Service. More information was requested on how this data will be prepared for regression analysis.

Information on GP practice quality is given by sex, age band, deprivation index, patient satisfaction, practice demographics. How will this information be quantified for regression analysis?

More information on the regression analysis needs to be given. 4. Will all 2500 patient cancer records be used in the analysis?

You kindly responded to the queries as follows:

The data that will be used for this research is coming from existing databases, which have been widely used for analysis and research. Initial preparation will involve moving the data from excel files, as they will be supplied by NYCRIS and from the public health observatory websites in this format, and combining them into stata. The cancer staging data will be linked with the relevant practice data from the practice profiles through the GP practice code, which NYCRIS will supply along with the cancer data.

In the case of the cancer data, staging data for all three cancers will be in the TNM staging system. It is the aim that all cancer records that are provide by NYCRIS should be used.

The GP practice information is already in an interval format as many of the variables, particularly the ones being used in this research, have come from the QOF and GP patient survey data. The majority of this data, with the exception of deprivation index, is provided as a percentage and provides upper and lower confidence intervals for each variable as well as comparable data for PCT and national level.

It was decided that a regression analysis, specifically using general linear or stepwise models, would be best as these allow for the combination of interval and nominal datasets. There is also the potential to use multi-level modeling as an additional method of analysis to further investigate the relationship between practice quality and cancer stage at diagnosis should any link be found via the regression analysis.

On behalf of the Committee, the sub committee gave a favourable ethical opinion of the above research on the basis described in the application form, protocol and supporting documentation, subject to the conditions specified below.

Ethical review of research sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see 'Conditions of the favourable opinion' below).

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

The favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

Management permission ("R&D approval") should be sought from all NHS organisation(s) involved in the study in accordance with NHS research governance arrangements. Guidance on applying for NHS permission for research is available in the Integrated Research Application System (IRAS) or at http://www.rdforum.nhs.uk.

Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of approvals from host organisations.

Approved Documents

The documents reviewed and approved were:

Document	*Version*	*Date*	
REC application	IRAS 3.1	30 December 2010	
Peer Review Letter	1	07 December 2010	
Protocol	1	30 December 2010	
Evidence of insurance or indemnity	1 - Professional Indemnity	05 July 2010	
Evidence of insurance or indemnity	1 - Employer''s Liability	02 July 2010	
Investigator CV	1	30 December 2010	
Investigator CV	1	20 December 2010	
Email correspondence from NIGB	1		

Membership of the Proportionate Review Sub Committee

The members of the sub-committee who took part in the review are listed on the attached sheet.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees (July 2001) and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After Ethical Review

Now that you have completed the application process please visit the National Research Ethics Service website >After Review

You are invited to give your view of the service that you have received from the National Research Ethics Service and the application procedure. If you wish to make your views known please use the feedback form available on the website.

The attached document 'After ethical review – guidance for researchers' gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Progress and safety reports
- Notifying the end of the study

The NRES website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

We would also like to inform you that we consult regularly with stakeholders to improve our service. If you would like to join our Reference Group please email referencegroup@nres.npsa.nhs.uk

11/H0904/4	**Please quote this number on all correspondence**

With the Committee's best wishes for the success of this project.

Yours sincerely

Cheryl Anderson

Vice Chair

Email: leigh.pollard@nhs.net

Enclosures: List of names and professions of members who took part in the review

'After ethical review – guidance for researchers'

Copy to: *Professor D Petley Dept of Geography, Durham University, South Road, Durham, DH1 3LE*

Sunderland Research Ethics Committee

Attendance at PRS Sub-Committee of the REC meeting on 14 January 2011 via email correspondence

Mrs Cheryl Anderson	**Vice Chair**	**Lay Member**
Mrs Gaynor Mitchell		**Lay Member**
Mrs J Ryan		**Expert Member (Co-Opted)**

Table 20. Appendix 2, correlation table of colorectal cancer variables. *p = <.05

	Sex	Age2	Stage	income~n	qofC	qofO	qofP	qofA	qofTotal	cance~wV	cance~vV	except~V	elderlyV	depriv~V	IDAOPIV	phonea~V	drtwod~V	bookingV	openho~V	perfer~V	sevent~V	eighty~V
Sex	1.0000																					
Age2	0.0423*	1.0000																				
Stage	−0.0159	−0.0271*	1.0000																			
incomedomain	−0.0090	0.0244*	0.0531*	1.0000																		
qofC	−0.0054	0.0037	0.0062	−0.0670*	1.0000																	
qofO	0.0132	−0.0004	0.0026	−0.0458*	0.2997*	1.0000																
qofP	0.0241*	−0.0019	−0.0178	−0.1704*	0.1462*	0.1101*	1.0000															
qofA	0.0114	−0.0050	0.0099	0.0048	0.4866*	0.2452*	0.0253*	1.0000														
qofTotal	0.0128	0.0007	−0.0046	−0.1450*	0.8095*	0.4694*	0.6622*	0.4302*	1.0000													
cancerrevi~V	−0.0029	0.0061	0.0108	−0.0204*	0.4868*	0.1544*	0.1243*	0.2146*	0.4228*	1.0000												
cancerprevV	0.0083	0.0080	−0.0100	−0.1738*	0.0899*	0.0622*	0.1917*	0.0400*	0.1773*	0.0047	1.0000											
exceptionr~V	0.0046	0.0065	−0.0091	0.0028	−0.1681*	−0.0099	−0.0568*	−0.0152	−0.1408*	−0.2775*	0.0495*	1.0000										
elderlyV	0.0069	0.0260*	−0.0010	−0.2288*	0.0941*	0.0543*	0.2053*	0.0453*	0.1850*	0.0976*	0.5043*	0.0261*	1.0000									
deprivationV	−0.0189*	−0.0019	0.0217*	0.4969*	−0.1319*	−0.0879*	−0.2957*	−0.0203*	−0.2649*	−0.0435*	−0.3436*	−0.0168	−0.4584*	1.0000								
IDAOPIV	−0.0161	−0.0030	0.0212*	0.4836*	−0.1411*	−0.0457*	−0.2690*	−0.0175	−0.2476*	−0.0642*	−0.3658*	0.0184*	−0.5109*	0.9196*	0.0168	0.5075*	0.0724*	0.1524*	−0.0022	0.1375*	−0.2379*	
phoneaccessV	0.0102	−0.0048	−0.0090	−0.1119*	0.1107*	0.0808*	0.6503*	0.0577*	0.4444*	0.1241*	0.1393*	0.0102	0.0905*	−0.1685*	−0.0249*	0.3280*	0.1021*	0.0974*	−0.0782*	0.0732*	0.1073*	
drtwodaysV	−0.0000	−0.0010	−0.0229*	−0.1497*	0.1309*	0.0733*	0.6284*	0.0463*	0.4425*	0.1398*	0.1140*	−0.1081*	0.2166*	−0.2481*	0.0047	0.3521*	0.0751*	0.1722*	0.0042	0.2393*	−0.2122*	
bookingV	0.0172	0.0011	−0.0100	−0.1438*	0.0827*	0.1089*	0.7899*	0.0168	0.5075*	0.0724*	0.1524*	−0.0022	0.1375*	−0.2379*	0.0394*	0.1782*	0.0872*	0.4541*	0.0432*	0.9298*	−0.4086*	
openhoursV	−0.0056	−0.0015	0.0065	0.0360*	0.0514*	0.0773*	0.5145*	−0.0249*	0.3280*	0.1021*	0.0974*	−0.0782*	0.0732*	0.1073*	0.0426*	0.1635*	0.0648*	0.3763*	0.0705*	0.7243*	−0.4316*	
perferredGPV	0.0144	−0.0050	−0.0104	−0.1117*	0.0090	0.0563*	0.6172*	0.0047	0.3521*	0.0751*	0.1722*	0.0042	0.2393*	−0.2122*								
seventyfiveV	0.0055	0.0272*	−0.0037	−0.2117*	0.0866*	0.0630*	0.1980*	0.0394*	0.1782*	0.0872*	0.4541*	0.0432*	0.9298*	−0.4086*	IDAOPIV	phonea~V	drtwod~V	bookingV	openho~V	perfer~V	sevent~V	
eightyfiveV	0.0074	0.0231*	−0.0096	−0.2251*	0.0798*	0.0492*	0.1841*	0.0426*	0.1635*	0.0648*	0.3763*	0.0705*	0.7243*	−0.4316*	1.0000							0.2197*
																						0.0767*

Table 21. Appendix 3, correlation table of breast cancer variables. * p = <.05

	Sex	Age	stage	income~n	qofC	qofO	qofP	qofA	qofTotal	ca~rrevV	ca~prevV	except~V	elderlyV	depriv~	IDAOPIV	phonea~V	drtwod~V	bookingV	openin~V	prefer~V	sevent~V	eighty~V
Sex	1.0000																					
Age	−0.0276*	1.0000																				
stage	−0.0159	0.1936*	1.0000																			
income_dom~n	−0.0005	0.0365*	0.0608*	1.0000																		
qofC	0.0015	0.0164	−0.0095	−0.0525*	1.0000																	
qofO	−0.0049	0.0065	0.0053	−0.0438*	0.3015*	1.0000																
qofP	−0.0069	0.0002	−0.0135	−0.1568*	0.1433*	0.0911*	1.0000															
qofA	−0.0049	−0.0047	0.0017	0.0081	0.5101*	0.2725*	0.0279*	1.0000														
qofTotal	−0.0040	0.0117	−0.0122	−0.1280*	0.8076*	0.4699*	0.6589*	0.4531*	1.0000													
cancerrevV	−0.0032	0.0141	−0.0148	−0.0128	0.4815*	0.1918*	0.0797*	0.2347*	0.4032*	1.0000												
cancerprevV	−0.0027	0.0175*	−0.0044	−0.1767*	0.1085*	0.0943*	0.1928*	0.0242*	0.1965*	−0.0254*	1.0000											
exceptionr~V	−0.0030	−0.0136	−0.0080	−0.0052	−0.1388*	−0.0118	−0.0572*	−0.0210*	−0.1227*	−0.2407*	0.0356*	1.0000										
elderlyV	−0.0004	0.0449*	−0.0160	−0.2188*	0.0992*	0.0310*	0.1885*	0.0335*	0.1738*	0.0557*	0.5041*	0.0202*	1.0000									
deprivationV	0.0030	−0.0100	0.0441*	0.5077*	−0.1310*	−0.0866*	−0.2873*	−0.0285*	−0.2607*	−0.0211*	−0.3578*	−0.0011	−0.4442*	1.0000								
IDAOPIV	0.0092	−0.0113	0.0456*	0.4921*	−0.1362*	−0.0472*	−0.2690*	−0.0247*	−0.2452*	−0.0273*	−0.3854*	0.0308*	−0.5077*	0.9153*	1.0000							
phoneaccessV	−0.0120	−0.0099	−0.0097	−0.1092*	0.1024*	0.0654*	0.6691*	0.0412*	0.4469*	0.0792*	0.1557*	0.0049	0.0856*	−0.1739*	−0.1772*	1.0000						
drtwodaysV	−0.0152	−0.0043	−0.0181*	−0.1474*	0.1170*	0.0788*	0.6548*	0.0232*	0.4491*	0.0856*	0.1124*	−0.0957*	0.1981*	−0.2318*	−0.2432*	0.3842*	1.0000					
bookingV	0.0021	0.0017	−0.0108	−0.1369*	0.0979*	0.0851*	0.8108*	0.0035	0.5250*	0.0435*	0.1634*	−0.0097	0.1235*	−0.2378*	−0.2224*	0.6915*	0.2713*	1.0000				
openinghou~V	−0.0137	−0.0008	0.0119	0.0447*	0.0550*	0.0965*	0.5259*	−0.0381*	0.3413*	0.0614*	0.1192*	−0.0710*	0.0700*	0.1089*	0.0717*	0.4922*	0.4815*	0.4291*	1.0000			
preferGPV	−0.0025	0.0028	0.0040	−0.0959*	0.0085	0.0503*	0.6307*	−0.0138	0.3588*	0.0390*	0.1707*	−0.0004	0.2249*	−0.1978*	−0.1979*	0.5527*	0.3947*	0.5945*	0.4400*	1.0000		
seventyfiveV	0.0018	0.0514*	−0.0170*	−0.2032*	0.0835*	0.0274*	0.1787*	0.0222*	0.1575*	0.0432*	0.4544*	0.0350*	0.9322*	−0.3965*	−0.4329*	0.0936*	0.1591*	0.1277*	0.0577*	0.1899*	1.0000	
eightyfiveV	0.0066	0.0407*	−0.0264*	−0.2156*	0.0583*	0.0169*	0.1732*	0.0165	0.1360*	0.0335*	0.3798*	0.0469*	0.7293*	−0.4175*	−0.4198*	0.1281*	0.1376*	0.1422*	0.0387*	0.1791*	0.8195*	1.0000

Table 22. Appendix 4. Regression output for colorectal cancer

```
Multinomial logistic regression                 Number of obs   =      11491
                                                LR chi2(84)     =     145.84
                                                Prob > chi2     =     0.0000
Log likelihood = -17880.668                     Pseudo R2       =     0.0041

------------------------------------------------------------------------------
       Stage |        RRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
1            |  (base outcome)
-------------+----------------------------------------------------------------
2            |
         Sex |   1.032102    .076307     0.43   0.669     .8928742     1.19304
        Age2 |   1.160068   .0975249     1.77   0.077     .9838401    1.367863
incomedomain |   1.065076   .0317825     2.11   0.035      1.00457    1.129226
        qofC |   1.030055   .0610158     0.50   0.617     .9171473    1.156863
        qofO |   1.030545   .0609877     0.51   0.611     .9176832    1.157287
        qofP |   1.022179   .0605732     0.37   0.711     .9100932     1.14807
        qofA |   1.047298    .065228     0.74   0.458     .9269489    1.183273
    qofTotal |   .9723868   .0575794    -0.47   0.636     .8658359     1.09205
cancerrevi~V |   1.197309    .578635     0.37   0.709     .4643419     3.08727
```

cancerprevV	.1904272	1.5864	-0.20	0.842	1.54e-08	2348928
exceptionr~V	.7155785	.4900084	-0.49	0.625	.1869726	2.73865
elderlyV	17.38697	53.40134	0.93	0.352	.0422565	7154.096
deprivationV	.9934199	.0093556	-0.70	0.483	.9752515	1.011927
IDAOPIV	.5018519	.6859069	-0.50	0.614	.0344504	7.310662
phoneaccessV	1.15257	.4161332	0.39	0.694	.5679922	2.338794
drtwodaysV	.6972154	.4446193	-0.57	0.572	.1997789	2.433237
bookingV	1.323565	.6834361	0.54	0.587	.4810814	3.641428
openhoursV	.9459607	.7995883	-0.07	0.948	.1804602	4.958664
perferredGPV	1.178247	.4607914	0.42	0.675	.5474527	2.535865
seventyfiveV	.0047524	.030498	-0.83	0.405	1.64e-08	1378.366
eightyfiveV	.0537416	.506442	-0.31	0.756	5.12e-10	5645837
3						
Sex	.9861577	.0740705	-0.19	0.853	.8511626	1.142563
Age2	.8795283	.0733831	-1.54	0.124	.7468445	1.035785
incomedomain	1.057005	.0319976	1.83	0.067	.9961153	1.121617
qofC	1.039984	.0624736	0.65	0.514	.9244721	1.16993
qofO	1.042611	.0625695	0.70	0.487	.9269141	1.172748
qofP	1.041033	.06256	0.67	0.503	.9253633	1.171161
qofA	1.069427	.0675764	1.06	0.288	.9448526	1.210425
qofTotal	.9619481	.0577644	-0.65	0.518	.8551406	1.082096

cancerrevi~V	.6533923	.3105134	-0.90	0.371	.2574276	1.658413
cancerprevV	.0161077	.1360587	-0.49	0.625	1.04e-09	249443.6
exceptionr~V	.6059449	.4101525	-0.74	0.459	.1607944	2.283469
elderlyV	18.29217	56.9276	0.93	0.350	.0410408	8152.941
deprivationV	1.000379	.0095396	0.04	0.968	.9818558	1.019252
IDAOPIV	.3577681	.4950897	-0.74	0.458	.0237511	5.389129
phoneaccessV	1.326689	.4872059	0.77	0.441	.6459199	2.724957
drtwodaysV	.3773445	.2441515	-1.51	0.132	.1061669	1.34118
bookingV	.943334	.4923406	-0.11	0.911	.3391645	2.623739
openhoursV	.4855748	.4158205	-0.84	0.399	.0906426	2.601237
perferredGPV	1.201872	.4773238	0.46	0.643	.5518272	2.61766
seventyfiveV	.0027774	.0180786	-0.90	0.366	8.00e-09	964.56
eightyfiveV	42.34847	404.2759	0.39	0.695	3.17e-07	5.66e+09
4						
Sex	1.006825	.0739335	0.09	0.926	.8718627	1.162678
Age2	.8312587	.0676645	-2.27	0.023	.7086771	.9750436
incomedomain	1.120863	.0331937	3.85	0.000	1.057656	1.187846
qofC	1.030061	.0605388	0.50	0.614	.9179856	1.155819
qofO	1.033014	.0606538	0.55	0.580	.9207198	1.159003
qofP	1.013799	.0596247	0.23	0.816	.9034208	1.137663
qofA	1.057608	.0653515	0.91	0.365	.9369737	1.193773

qofTotal	.9713624	.0570721	-0.49	0.621	.8657035	1.089917
cancerrevi~V	.9386144	.4399113	-0.14	0.892	.3745801	2.351959
cancerprevV	.0001264	.0010437	-1.09	0.277	1.18e-11	1350.129
exceptionr~V	.6655139	.4425227	-0.61	0.540	.1807858	2.449908
elderlyV	59.44135	181.5047	1.34	0.181	.1496017	23617.88
deprivationV	.9931029	.0092393	-0.74	0.457	.9751582	1.011378
IDAOPIV	1.145689	1.543013	0.10	0.920	.0817843	16.04959
phoneaccessV	1.246182	.4460212	0.61	0.539	.6179141	2.513247
drtwodaysV	1.431969	.9080253	0.57	0.571	.4132174	4.962365
bookingV	2.20665	1.145002	1.53	0.127	.7980975	6.101138
openhoursV	.9697271	.8142144	-0.04	0.971	.187048	5.02743
perferredGPV	1.383412	.5354498	0.84	0.402	.6478789	2.953991
seventyfiveV	.0001058	.0006758	-1.43	0.152	3.88e-10	28.83436
eightyfiveV	296.6377	2782.607	0.61	0.544	3.07e-06	2.86e+10
Unknown						
Sex	.9373915	.0678862	-0.89	0.372	.8133485	1.080352
Age2	.9087217	.0733184	-1.19	0.235	.7758065	1.064409
incomedomain	1.137169	.033238	4.40	0.000	1.073854	1.204216
qofC	1.022993	.0592971	0.39	0.695	.9131317	1.146072
qofO	1.023982	.059299	0.41	0.682	.914111	1.147058
qofP	1.023363	.0593456	0.40	0.690	.9134148	1.146546

qofA	1.043463	.0636073	0.70	0.485	.9259549	1.175884
qofTotal	.9786313	.0567062	-0.37	0.709	.8735681	1.09633
cancerrevi~V	1.291854	.6082395	0.54	0.587	.5133871	3.250738
cancerprevV	.0008542	.0069457	-0.87	0.385	1.02e-10	7127.439
exceptionr~V	.5477527	.3676425	-0.90	0.370	.1469848	2.041253
elderlyV	128.6995	386.5041	1.62	0.106	.3575115	46330.17
deprivationV	.9915663	.0090829	-0.92	0.355	.973923	1.009529
IDAOPIV	.8115994	1.076209	-0.16	0.875	.0603418	10.91603
phoneaccessV	1.198323	.4223868	0.51	0.608	.600539	2.39115
drtwodaysV	.2197106	.136122	-2.45	0.014	.0652361	.7399702
bookingV	.7807198	.3890265	-0.50	0.619	.2940006	2.073204
openhoursV	2.550401	2.109622	1.13	0.258	.5041012	12.90325
perferredGPV	.8899758	.3393884	-0.31	0.760	.4214793	1.879231
seventyfiveV	.0032136	.0201792	-0.91	0.361	1.45e-08	711.1029
eightyfiveV	.0050196	.0462717	-0.57	0.566	7.15e-11	352548.1

Table 23. Appendix 5. Regression output for colorectal cancer of top and bottom deciles of QOF total score

```
Multinomial logistic regression                 Number of obs   =       2340
                                                LR chi2(84)     =      75.41
                                                Prob > chi2     =     0.7374
Log likelihood = -3643.9045                     Pseudo R2       =     0.0102

------------------------------------------------------------------------------
```

Stage	RRR	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1	(base outcome)					
2						
Sex	.9864838	.1553375	-0.09	0.931	.7245273	1.343152
Age2	1.121778	.20584	0.63	0.531	.7829182	1.607303
incomedomain	1.112701	.0739612	1.61	0.108	.9767858	1.267529
qofC	1.239765	.1667042	1.60	0.110	.9525397	1.613599
qofO	1.245419	.1684634	1.62	0.105	.9553811	1.623509
qofP	1.199817	.1619154	1.35	0.177	.9209692	1.563092
qofA	1.234899	.1737997	1.50	0.134	.9372025	1.627157
qofTotal	.811796	.1091731	-1.55	0.121	.6236981	1.056621
cancerrevi~V	1.726359	1.244037	0.76	0.449	.4204784	7.087912
cancerprevV	3.94e-07	7.73e-06	-0.75	0.452	7.97e-24	1.95e+10
exceptionr~V	5.014416	5.685237	1.42	0.155	.5434333	46.26946
elderlyV	511.2832	3507.496	0.91	0.363	.0007401	3.53e+08
deprivationV	.9942759	.0200788	-0.28	0.776	.9556908	1.034419
IDAOPIV	.2163749	.5941278	-0.56	0.577	.0009953	47.03896
phoneaccessV	1.623881	1.2827	0.61	0.539	.3452963	7.636887
drtwodaysV	8.701534	12.56803	1.50	0.134	.5130571	147.5795
bookingV	3.361388	4.870427	0.84	0.403	.1964194	57.52452
openhoursV	.4849207	.9384503	-0.37	0.708	.0109237	21.52641
perferredGPV	.1617983	.1584511	-1.86	0.063	.0237346	1.102977

```
seventyfiveV |   .0336886   .4651799    -0.25   0.806     5.94e-14    1.91e+10
 eightyfiveV |   .0023947    .044335    -0.33   0.744     4.17e-19    1.38e+13
-------------+----------------------------------------------------------------
3            |
         Sex |   .9653234   .1539466    -0.22   0.825     .7061973    1.319531
        Age2 |   .7878737   .1417161    -1.33   0.185     .5537958    1.120892
incomedomain |    1.06973   .0716139     1.01   0.314     .9381874    1.219715
        qofC |   1.091389   .1490888     0.64   0.522     .8350292    1.426454
        qofO |     1.0912   .1498064     0.64   0.525     .8337705    1.428113
        qofP |   1.051057   .1440357     0.36   0.716     .8034864    1.374909
        qofA |   1.104938   .1585918     0.70   0.487     .8339974    1.463898
    qofTotal |   .9228917   .1260974    -0.59   0.557     .7060713    1.206293
cancerrevi~V |   .5947928   .4006974    -0.77   0.441     .1588298    2.227406
 cancerprevV |   2.36e-07   4.68e-06    -0.77   0.442     3.08e-24    1.81e+10
exceptionr~V |   2.076705   2.238822     0.68   0.498     .2510293    17.18007
    elderlyV |   399.9446    2778.55     0.86   0.388      .000488    3.28e+08
deprivationV |   1.005586   .0203959     0.27   0.784     .9663946    1.046366
     IDAOPIV |   .1595574    .439153    -0.67   0.505     .0007247     35.1314
phoneaccessV |   1.928976   1.548565     0.82   0.413     .3999353    9.303879
  drtwodaysV |   2.177459    3.19502     0.53   0.596      .122735     38.6306
    bookingV |   4.737193   6.909132     1.07   0.286     .2716784    82.60133
  openhoursV |   .6672062   1.317245    -0.20   0.838     .0139238     31.9714
perferredGPV |   1.011468   1.003276     0.01   0.991     .1447586    7.067403
seventyfiveV |   .0217169   .3029134    -0.27   0.784     2.91e-14    1.62e+10
```

eightyfiveV	.4625606	8.672615	-0.04	0.967	5.08e-17	4.21e+15
4						
Sex	1.017256	.1607362	0.11	0.914	.7463327	1.386527
Age2	.7303373	.1298515	-1.77	0.077	.5154455	1.034818
incomedomain	1.139022	.0758125	1.96	0.050	.9997165	1.29774
qofC	1.182106	.1607277	1.23	0.219	.9055672	1.543092
qofO	1.184178	.1617138	1.24	0.216	.9060975	1.5476
qofP	1.127548	.153744	0.88	0.379	.863121	1.472986
qofA	1.2044	.1714425	1.31	0.191	.9111812	1.591976
qofTotal	.8493387	.115453	-1.20	0.230	.6506908	1.108631
cancerrevi~V	1.59098	1.086005	0.68	0.496	.4174778	6.063115
cancerprevV	1.86e-13	3.66e-12	-1.49	0.136	3.49e-30	9944.041
exceptionr~V	5.120608	5.448875	1.53	0.125	.6361391	41.21839
elderlyV	4047.497	27924.52	1.20	0.229	.0054271	3.02e+09
deprivationV	.9797776	.0197509	-1.01	0.311	.9418213	1.019264
IDAOPIV	1.821004	4.949306	0.22	0.825	.0088477	374.7927
phoneaccessV	2.133905	1.6889	0.96	0.338	.4523588	10.06623
drtwodaysV	9.185653	13.35165	1.53	0.127	.5319377	158.6205
bookingV	13.36697	19.25134	1.80	0.072	.7945435	224.8786
openhoursV	1.59959	3.143182	0.24	0.811	.0339941	75.26855
perferredGPV	.3963011	.3876373	-0.95	0.344	.0582683	2.695369
seventyfiveV	.0000413	.0005726	-0.73	0.467	6.38e-17	2.67e+07
eightyfiveV	.0001908	.0035892	-0.46	0.649	1.87e-20	1.95e+12

```
-------------+----------------------------------------------------------------

Unknown      |

         Sex |   .9446125   .1444725    -0.37   0.709     .6999513    1.274793

        Age2 |   .8135653   .1410252    -1.19   0.234     .5792197    1.142724

incomedomain |   1.117073   .0718065     1.72   0.085     .9848395    1.267061

        qofC |   1.142916   .1486379     1.03   0.304     .8857564    1.474736

        qofO |   1.141261   .1491922     1.01   0.312     .8833061    1.474549

        qofP |   1.107889   .1444388     0.79   0.432     .8580696    1.430441

        qofA |   1.126441   .1534115     0.87   0.382     .8625456    1.471074

    qofTotal |   .8790489   .1143043    -0.99   0.321     .6812865    1.134217

cancerrevi~V |   1.384858   .9148405     0.49   0.622     .3794017    5.054882

 cancerprevV |   1.51e-06   .0000288    -0.70   0.482     9.13e-23    2.49e+10

exceptionr~V |   1.592944   1.756097     0.42   0.673     .1835764    13.82242

    elderlyV |   10.73257   71.56708     0.36   0.722     .0000226     5089796

deprivationV |   .9862183   .0193606    -0.71   0.480     .9489929    1.024904

     IDAOPIV |   .8695913   2.309707    -0.05   0.958     .0047693     158.554

phoneaccessV |   1.531626   1.175529     0.56   0.579     .3402923    6.893715

  drtwodaysV |   3.071715   4.288165     0.80   0.421     .1991083    47.38844

    bookingV |   5.561176   7.783932     1.23   0.220     .3578879    86.41444

  openhoursV |   .7616285   1.438792    -0.14   0.885     .0187819    30.88498

perferredGPV |   .5570431   .5268776    -0.62   0.536     .0872534    3.556275

seventyfiveV |   3.481399    46.5542     0.09   0.926     1.44e-11    8.40e+11

 eightyfiveV |   .0011639   .0209669    -0.38   0.708     5.39e-19    2.51e+12
```

Table 24. Appendix 6. Regression output for breast cancer

```
Multinomial logistic regression                 Number of obs   =       8646
                                                LR chi2(80)     =     614.05
                                                Prob > chi2     =     0.0000
Log likelihood = -11270.588                     Pseudo R2       =     0.0265

------------------------------------------------------------------------------
       stage |        RRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
1            |  (base outcome)
-------------+----------------------------------------------------------------
2            |
         Age |   1.042447   .0544917     0.80   0.426     .9409341    1.154911
income_dom~n |   1.013582   .0217131     0.63   0.529     .9719058    1.057045
        qofC |    1.01864   .0427464     0.44   0.660     .9382111    1.105963
        qofO |   1.018075   .0425475     0.43   0.668     .9380073    1.104977
        qofP |   1.018787   .0427238     0.44   0.657     .9383992    1.106062
        qofA |   .9950925   .0439985    -0.11   0.911     .9124879    1.085175
    qofTotal |   .9834413   .0412352    -0.40   0.690     .9058537    1.067675
  cancerrevV |   1.178704   .3931829     0.49   0.622       .61301    2.266428
 cancerprevV |   49.30148   285.7124     0.67   0.501     .0005754     4224267
exceptionr~V |   1.136761   .5863657     0.25   0.804     .4136194    3.124188
    elderlyV |   .0385173   .0827565    -1.52   0.130     .0005712    2.597221
```

```
deprivationV |    1.01108   .0066198     1.68   0.092     .9981883    1.024138
     IDAOPIV |   .5010236   .4683795    -0.74   0.460     .0801893      3.1304
phoneaccessV |   1.185202   .3012523     0.67   0.504     .7201714    1.950515
  drtwodaysV |   .7822216   .3498785    -0.55   0.583     .3255348    1.879586
    bookingV |   .5607552     .20848    -1.56   0.120     .2705888    1.162082
openinghou~V |   .4791623   .2877029    -1.23   0.220     .1477054    1.554421
   preferGPV |   1.699778   .4668472     1.93   0.053     .9922204    2.911899
seventyfiveV |   458.1953    2070.27     1.36   0.175     .0653213     3214006
 eightyfiveV |   .0376273   .2476771    -0.50   0.618     9.39e-08    15081.07
-------------+----------------------------------------------------------------
3            |
         Age |   1.090611   .0913863     1.04   0.301      .925432    1.285272
income_dom~n |   1.008439   .0346597     0.24   0.807     .9427449    1.078711
        qofC |   1.032593   .0695653     0.48   0.634     .9048658     1.17835
        qofO |    1.05533   .0708137     0.80   0.422     .9252767    1.203662
        qofP |   1.039295    .070006     0.57   0.567     .9107571    1.185974
        qofA |   1.012544   .0717393     0.18   0.860     .8812633    1.163381
    qofTotal |   .9661939   .0650319    -0.51   0.609     .8467832    1.102444
  cancerrevV |   1.130923   .5946247     0.23   0.815      .403536    3.169449
 cancerprevV |   .0267991   .2513739    -0.39   0.700     2.78e-10     2584193
exceptionr~V |    .966559   .7780918    -0.04   0.966     .1995266    4.682265
    elderlyV |   .0142491   .0494922    -1.22   0.221     .0000157    12.89185
deprivationV |   1.008611   .0103592     0.83   0.404     .9885101     1.02912
     IDAOPIV |   1.022509   1.480932     0.02   0.988     .0598198    17.47791
```

phoneaccessV	1.02986	.4236097	0.07	0.943	.4598914	2.30622
drtwodaysV	.6356859	.4615495	-0.62	0.533	.1531844	2.637974
bookingV	1.070482	.671734	0.11	0.914	.3129288	3.661959
openinghou~V	.2032289	.1963322	-1.65	0.099	.0305964	1.349898
preferGPV	1.891914	.8418636	1.43	0.152	.7909225	4.525525
seventyfiveV	1012.47	7373.727	0.95	0.342	.00064	1.60e+09
eightyfiveV	.0000402	.0004262	-0.95	0.340	3.77e-14	42822.12
4						
Age	2.146935	.2071182	7.92	0.000	1.77706	2.593795
income_dom~n	1.093708	.0436122	2.25	0.025	1.011485	1.182615
qofC	.82093	.0634539	-2.55	0.011	.7055249	.9552123
qofO	.8198378	.063129	-2.58	0.010	.7049915	.9533931
qofP	.8243793	.0636973	-2.50	0.012	.7085284	.9591728
qofA	.8028211	.0649018	-2.72	0.007	.6851816	.9406581
qofTotal	1.218007	.0940725	2.55	0.011	1.046905	1.417073
cancerrevV	1.097795	.6402831	0.16	0.873	.3499956	3.443341
cancerprevV	.3869602	4.137073	-0.09	0.929	3.07e-10	4.88e+08
exceptionr~V	1.426103	1.262478	0.40	0.688	.2515431	8.085169
elderlyV	1421.028	5690.165	1.81	0.070	.5548429	3639444
deprivationV	1.002258	.0117485	0.19	0.847	.9794937	1.025551
IDAOPIV	6.539637	10.78184	1.14	0.255	.2583362	165.5473
phoneaccessV	.8833132	.4071103	-0.27	0.788	.3579352	2.179842
drtwodaysV	1.577513	1.277081	0.56	0.573	.3227603	7.710203

bookingV	.5671669	.3820578	-0.84	0.400	.1514678	2.123741
openinghou~V	.2706802	.299092	-1.18	0.237	.0310391	2.360499
preferGPV	1.47645	.7344652	0.78	0.433	.5569109	3.91428
seventyfiveV	2.99e-07	2.53e-06	-1.78	0.075	1.96e-14	4.580244
eightyfiveV	6.668179	81.86139	0.15	0.877	2.37e-10	1.88e+11
unknown						
Age	5.261777	.4883817	17.89	0.000	4.386586	6.311583
income_dom~n	1.06711	.0363513	1.91	0.057	.9981896	1.14079
qofC	1.025193	.0682651	0.37	0.709	.8997591	1.168114
qofO	1.022637	.0677688	0.34	0.736	.8980769	1.164473
qofP	1.024137	.0680862	0.36	0.720	.8990189	1.166668
qofA	1.052621	.0739961	0.73	0.466	.9171389	1.208117
qofTotal	.9756474	.0648885	-0.37	0.711	.8564086	1.111488
cancerrevV	.3242332	.1580274	-2.31	0.021	.124736	.8427971
cancerprevV	4.44e+08	4.05e+09	2.19	0.029	7.77811	2.54e+16
exceptionr~V	.2733443	.2312044	-1.53	0.125	.0520875	1.434455
elderlyV	10.53973	35.63656	0.70	0.486	.0139565	7959.442
deprivationV	.9962867	.010156	-0.36	0.715	.9765788	1.016392
IDAOPIV	3.771301	5.477904	0.91	0.361	.2188269	64.99525
phoneaccessV	1.294933	.518162	0.65	0.518	.591075	2.836952
drtwodaysV	.3667392	.2527654	-1.46	0.146	.0949924	1.415878
bookingV	.6036123	.3339736	-0.91	0.362	.2040776	1.785339
openinghou~V	13.08558	12.66998	2.66	0.008	1.961667	87.28919

```
   preferGPV |   2.060301   .8971706     1.66   0.097     .8775454    4.837172
seventyfiveV |   1.193635   8.556229     0.02   0.980     9.45e-07     1508227
 eightyfiveV |   3.05e-11   3.15e-10    -2.34   0.019     4.87e-20    .0191493
------------------------------------------------------------------------------
```

Table 25. Appendix 7. Regression output for breast cancer with top and bottom deciles of QOF total score

```
Multinomial logistic regression                 Number of obs   =       1727
                                                LR chi2(80)     =     195.28
                                                Prob > chi2     =     0.0000
Log likelihood = -2194.4279                     Pseudo R2       =     0.0426

------------------------------------------------------------------------------
       stage |        RRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
1            |  (base outcome)
-------------+----------------------------------------------------------------
2            |
         Age |   1.108509   .1310879     0.87   0.384     .8791834    1.397652
income_dom~n |   1.056981   .0521006     1.12   0.261     .9596429    1.164191
        qofC |   .9775084   .0987685    -0.23   0.822     .8018888     1.19159
        qofO |    .966692   .0977286    -0.34   0.738     .7929305    1.178531
        qofP |   .9877455    .100678    -0.12   0.904     .8088809    1.206162
        qofA |   .9387794    .099714    -0.59   0.552     .7623454    1.156047
```

```
    qofTotal |    1.02502   .1036244     0.24   0.807     .8407757    1.249639
  cancerrevV |   1.412999    .760858     0.64   0.521     .4918074     4.05965
 cancerprevV |   2738.223   39360.23     0.55   0.582     1.59e-09    4.71e+15
exceptionr~V |   1.326661   1.121657     0.33   0.738      .252983    6.957104
    elderlyV |   .0047423    .024161    -1.05   0.294     2.18e-07    102.9585
deprivationV |   1.007284   .0143239     0.51   0.610     .9795969    1.035753
     IDAOPIV |   .0969202   .1871721    -1.21   0.227     .0022008    4.268277
phoneaccessV |   .5852591   .3384546    -0.93   0.354      .188408    1.818013
  drtwodaysV |   .1238527   .1238695    -2.09   0.037     .0174417    .8794723
    bookingV |   .2703389   .2807855    -1.26   0.208     .0353032    2.070154
openinghou~V |   15.74729   22.58827     1.92   0.055     .9467226    261.9321
   preferGPV |   3.613834   2.595667     1.79   0.074     .8842711    14.76899
seventyfiveV |   .0974664   1.004512    -0.23   0.821     1.65e-10    5.77e+07
 eightyfiveV |   21886.14   290449.7     0.75   0.451     1.11e-07    4.33e+15
-------------+----------------------------------------------------------------
3            |
         Age |   1.410984   .2718856     1.79   0.074     .9671686    2.058458
income_dom~n |   .9741418   .0787535    -0.32   0.746     .8313955    1.141397
        qofC |   .7021741   .1199009    -2.07   0.038     .5024541    .9812804
        qofO |   .7158411   .1225239    -1.95   0.051     .5118283    1.001172
        qofP |   .6977628    .120189    -2.09   0.037     .4978393     .977972
        qofA |   .6366102    .112064    -2.57   0.010     .4508526    .8989025
    qofTotal |   1.428738   .2438966     2.09   0.037     1.022459    1.996454
  cancerrevV |   .7307671   .6349939    -0.36   0.718     .1330867    4.012577
```

```
 cancerprevV |   2.68e+14   6.56e+15     1.36   0.174     4.04e-07    1.78e+35
exceptionr~V |   2.477506   2.814689     0.80   0.425       .26728    22.96481
    elderlyV |   .0693259   .5887766    -0.31   0.753     4.09e-09     1175028
deprivationV |    1.00546   .0237678     0.23   0.818     .9599387     1.05314
     IDAOPIV |   3.637991   11.35137     0.41   0.679     .0080337     1647.43
phoneaccessV |   .3718741   .3521435    -1.04   0.296     .0581242    2.379222
  drtwodaysV |   .9712897    1.57668    -0.02   0.986     .0403279     23.3933
    bookingV |    1.45388   2.528004     0.22   0.830      .048135     43.9133
openinghou~V |   1.312692    3.13251     0.11   0.909     .0122157     141.061
   preferGPV |   6.425006   7.530232     1.59   0.112     .6460243    63.89962
seventyfiveV |   1.228242    21.1983     0.01   0.990     2.50e-15    6.03e+14
 eightyfiveV |   6.35e-06    .000143    -0.53   0.595     4.13e-25    9.75e+13
-------------+----------------------------------------------------------------
4            |
         Age |   2.324933   .5204974     3.77   0.000     1.499155    3.605573
income_dom~n |   1.160946   .1108063     1.56   0.118     .9628732    1.399764
        qofC |   .5883319   .1218686    -2.56   0.010     .3920147    .8829628
        qofO |   .5850423   .1210186    -2.59   0.010      .390043    .8775302
        qofP |   .5954316   .1237935    -2.49   0.013     .3961525    .8949552
        qofA |   .5638045   .1221204    -2.65   0.008     .3687718    .8619843
    qofTotal |   1.705661   .3532591     2.58   0.010     1.136581    2.559675
  cancerrevV |   .3517401   .3068456    -1.20   0.231     .0636303    1.944375
 cancerprevV |    3.95254   108.1393     0.05   0.960     2.03e-23    7.68e+23
exceptionr~V |   .7703513   1.004297    -0.20   0.841     .0598396    9.917204
```

elderlyV	444634	4444335	1.30	0.193	.0013798	1.43e+14
deprivationV	.9962126	.0265176	-0.14	0.887	.9455715	1.049566
IDAOPIV	3.077347	10.80179	0.32	0.749	.003165	2992.113
phoneaccessV	8.618001	9.631007	1.93	0.054	.9641623	77.03054
drtwodaysV	.0437812	.079883	-1.71	0.086	.0012252	1.564536
bookingV	.1100789	.2001554	-1.21	0.225	.0031187	3.885398
openinghou~V	2.540654	7.006125	0.34	0.735	.01142	565.2294
preferGPV	1.722533	2.334217	0.40	0.688	.1209758	24.52657
seventyfiveV	2.55e-13	5.14e-12	-1.44	0.151	1.63e-30	39817.74
eightyfiveV	.0461552	1.259473	-0.11	0.910	2.73e-25	7.79e+21
unknown						
Age	6.022633	1.249051	8.66	0.000	4.011006	9.043144
income_dom~n	1.154044	.0897704	1.84	0.065	.9908532	1.344111
qofC	.8018779	.1281299	-1.38	0.167	.5862691	1.09678
qofO	.8024827	.128207	-1.38	0.168	.5867394	1.097555
qofP	.8005051	.1288684	-1.38	0.167	.5838945	1.097473
qofA	.821007	.1372051	-1.18	0.238	.591692	1.139195
qofTotal	1.243433	.1987872	1.36	0.173	.9089527	1.700998
cancerrevV	.4044733	.3008158	-1.22	0.224	.0941526	1.737591
cancerprevV	1.64e+14	3.84e+15	1.40	0.163	1.83e-06	1.47e+34
exceptionr~V	.0788736	.1220874	-1.64	0.101	.0037964	1.638686
elderlyV	.0002512	.0020145	-1.03	0.301	3.75e-11	1682.059
deprivationV	.9977677	.0230432	-0.10	0.923	.9536108	1.043969

IDAOPIV	.0491173	.1538676	-0.96	0.336	.0001059	22.7906
phoneaccessV	.3367463	.3118927	-1.18	0.240	.0548182	2.068622
drtwodaysV	.406651	.6594782	-0.55	0.579	.0169357	9.7643
bookingV	1.830055	3.056663	0.36	0.717	.0693008	48.32703
openinghou~V	115.1611	270.3661	2.02	0.043	1.155906	11473.32
preferGPV	3.915241	4.424611	1.21	0.227	.4273818	35.86748
seventyfiveV	.0238994	.3876479	-0.23	0.818	3.73e-16	1.53e+12
eightyfiveV	3.95e+08	8.09e+09	0.97	0.334	1.40e-09	1.11e+26

Table 26. Appendix 8. Base outcome output for breast cancer, screen detected cases and patient's of screening age removed.

Multinomial logistic regression — Number of obs = 4101

LR chi2(88) = 441.42

Prob > chi2 = 0.0000

Log likelihood = -5292.1196 — Pseudo R2 = 0.0400

stage	RRR	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1	(base outcome)					
2						
Sex	.9300976	.322639	-0.21	0.835	.4712567	1.83569
Age	1.04247	.0810197	0.54	0.593	.8951776	1.213998

Screen_det~d	1.025288	.0396209	0.65	0.518	.9505008	1.10596
income_dom~n	1.026903	.0318274	0.86	0.392	.9663795	1.091217
qofC	1.014426	.0619626	0.23	0.815	.8999695	1.143439
qofO	1.015571	.0617875	0.25	0.800	.9014113	1.144188
qofP	1.007073	.0615897	0.12	0.908	.8933136	1.135319
qofA	.9598048	.0624145	-0.63	0.528	.8449495	1.090273
qofTotal	.9875454	.0602935	-0.21	0.837	.8761691	1.11308
cancerrevV	1.167417	.547328	0.33	0.741	.4657482	2.926177
cancerprevV	9431.217	78586.39	1.10	0.272	.0007618	1.17e+11
exceptionr~V	.9256643	.6742326	-0.11	0.916	.2220536	3.858773
elderlyV	.1351089	.4167171	-0.65	0.516	.0003201	57.02281
deprivationV	.9998654	.0095532	-0.01	0.989	.9813158	1.018766
IDAOPIV	2.631525	3.613905	0.70	0.481	.1783373	38.83048
phoneaccessV	1.616137	.5950589	1.30	0.192	.7853571	3.325747
drtwodaysV	1.476548	.9632081	0.60	0.550	.4111273	5.302963
bookingV	.6474844	.3452189	-0.82	0.415	.2277166	1.841043
openinghou~V	.2018222	.1741166	-1.86	0.064	.0372064	1.094762
preferGPV	2.345115	.9387549	2.13	0.033	1.070104	5.139277
seventyfiveV	714.04	4677.224	1.00	0.316	.0018969	2.69e+08
eightyfiveV	.002104	.0198323	-0.65	0.513	1.99e-11	222005.4
3						
Sex	.8604146	.4552973	-0.28	0.776	.3049901	2.427336
Age	1.088891	.133432	0.69	0.487	.856404	1.384491

Screen_det~d	1.009427	.0618142	0.15	0.878	.8952614	1.138151
income_dom~n	.9878648	.0482093	-0.25	0.802	.8977544	1.08702
qofC	1.057293	.1018307	0.58	0.563	.8754151	1.276959
qofO	1.088221	.1045503	0.88	0.379	.9014427	1.313699
qofP	1.068574	.1031727	0.69	0.492	.8843407	1.291188
qofA	.9885068	.1006846	-0.11	0.910	.8096183	1.206922
qofTotal	.941257	.0906283	-0.63	0.530	.7793828	1.136752
cancerrevV	1.318246	.950425	0.38	0.702	.3208482	5.416181
cancerprevV	668.5829	8881.647	0.49	0.624	3.29e-09	1.36e+14
exceptionr~V	1.273954	1.293835	0.24	0.812	.1740478	9.324783
elderlyV	9.19e-06	.0000452	-2.36	0.018	6.01e-10	.1406329
deprivationV	1.000466	.0148193	0.03	0.975	.9718379	1.029937
IDAOPIV	1.913411	4.030804	0.31	0.758	.0308079	118.8379
phoneaccessV	1.567038	.9147739	0.77	0.442	.4990939	4.920133
drtwodaysV	.2645488	.2764404	-1.27	0.203	.0341226	2.051016
bookingV	.7454711	.6605848	-0.33	0.740	.1312669	4.233568
openinghou~V	.3505684	.4787469	-0.77	0.443	.0241183	5.09565
preferGPV	1.126826	.7217112	0.19	0.852	.3211281	3.953991
seventyfiveV	1.74e+11	1.80e+12	2.49	0.013	257.1066	1.18e+20
eightyfiveV	3.50e-09	5.17e-08	-1.32	0.188	9.29e-22	13165.59
4						
Sex	.629131	.3376437	-0.86	0.388	.2197435	1.801217
Age	2.424239	.3521828	6.10	0.000	1.823546	3.222807

Screen_det~d	.9272999	.0679527	-1.03	0.303	.8032376	1.070524
income_dom~n	1.148034	.0683679	2.32	0.020	1.02156	1.290166
qofC	.7601744	.0879765	-2.37	0.018	.6059014	.953728
qofO	.764397	.0880102	-2.33	0.020	.6099784	.9579074
qofP	.7508751	.0870949	-2.47	0.014	.5981854	.9425396
qofA	.6997287	.0849136	-2.94	0.003	.5516131	.8876153
qofTotal	1.316682	.1522546	2.38	0.017	1.049669	1.651619
cancerrevV	.7361196	.5865182	-0.38	0.701	.1544317	3.508815
cancerprevV	.2365547	3.754614	-0.09	0.928	7.30e-15	7.66e+12
exceptionr~V	2.139989	2.451883	0.66	0.507	.2265432	20.21492
elderlyV	451355.4	2686717	2.19	0.029	3.869865	5.26e+10
deprivationV	.9865596	.0173588	-0.77	0.442	.953117	1.021176
IDAOPIV	9.946338	24.82999	0.92	0.357	.0745981	1326.169
phoneaccessV	3.289196	2.311951	1.69	0.090	.8294429	13.04346
drtwodaysV	1.417941	1.708132	0.29	0.772	.1337372	15.03363
bookingV	1.118656	1.149023	0.11	0.913	.1494132	8.375383
openinghou~V	.5095412	.8385852	-0.41	0.682	.0202442	12.825
preferGPV	.9463649	.707849	-0.07	0.941	.2184684	4.099478
seventyfiveV	2.02e-14	2.56e-13	-2.48	0.013	3.15e-25	.0012889
eightyfiveV	2060594	3.72e+07	0.81	0.420	8.95e-10	4.74e+21
unknown						
Sex	1.591492	.8530726	0.87	0.386	.5565993	4.550573
Age	5.460878	.7723778	12.00	0.000	4.138757	7.20535

Screen_det~d	1.576219	.1183678	6.06	0.000	1.360488	1.826158
income_dom~n	1.095176	.0560101	1.78	0.075	.990721	1.210644
qofC	1.13606	.113722	1.27	0.203	.9336722	1.38232
qofO	1.139721	.1133732	1.31	0.189	.9378332	1.385069
qofP	1.13025	.1130715	1.22	0.221	.9290081	1.375086
qofA	1.150312	.1222946	1.32	0.188	.9339436	1.416806
qofTotal	.8765135	.0876121	-1.32	0.187	.7205706	1.066205
cancerrevV	.6059616	.4525077	-0.67	0.502	.1402175	2.618714
cancerprevV	3.98e+18	5.46e+19	3.12	0.002	8307295	1.90e+30
exceptionr~V	.0754171	.1047813	-1.86	0.063	.0049528	1.1484
elderlyV	30.62963	156.4201	0.67	0.503	.0013779	680890.5
deprivationV	.9948419	.0151293	-0.34	0.734	.9656265	1.024941
IDAOPIV	3.638988	7.892454	0.60	0.551	.0518614	255.3391
phoneaccessV	1.441162	.8661314	0.61	0.543	.4437566	4.680377
drtwodaysV	.4829545	.502072	-0.70	0.484	.0629521	3.705119
bookingV	1.423067	1.176957	0.43	0.670	.2813413	7.19809
openinghou~V	24.4178	35.20225	2.22	0.027	1.447307	411.9577
preferGPV	1.110619	.7280478	0.16	0.873	.307308	4.013804
seventyfiveV	.0320112	.3486659	-0.32	0.752	1.71e-11	5.98e+07
eightyfiveV	4.62e-14	7.05e-13	-2.01	0.044	4.65e-27	.4593061

Table 27. Appendix 9. Base outcome output for breast cancer, screen detected cases and screening age patient's removed, with just top and bottom deciles of QOF total score.

```
Multinomial logistic regression                 Number of obs   =        828
                                                LR chi2(87)     =     171.36
                                                Prob > chi2     =     0.0000
Log likelihood = -1036.5142                     Pseudo R2       =     0.0764

------------------------------------------------------------------------------
       stage |        RRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
1            |  (base outcome)
-------------+----------------------------------------------------------------
2            |
         Sex |   4.538425   5.322395     1.29   0.197      .455687    45.20055
         Age |    1.32003   .2369412     1.55   0.122     .9285297      1.8766
Screen_det~d |   .9715892   .0849161    -0.33   0.742     .8186313    1.153127
income_dom~n |   1.007753    .073179     0.11   0.915     .8740643     1.16189
        qofC |   .8353657   .1246819    -1.21   0.228     .6234924    1.119237
        qofO |    .825985   .1234105    -1.28   0.201     .6163026    1.107007
        qofP |   .8540583   .1285216    -1.05   0.294     .6359103    1.147042
        qofA |   .7691898   .1219709    -1.65   0.098     .5637129    1.049564
    qofTotal |   1.197152   .1787148     1.21   0.228     .8934682    1.604056
  cancerrevV |   1.185779   .8921479     0.23   0.821     .2713831    5.181132
 cancerprevV |   5.86e+11   1.20e+13     1.32   0.185     2.25e-06    1.53e+29
exceptionr~V |   .5741981   .7052448    -0.45   0.651     .0517123    6.375722
    elderlyV |   1.593843   11.60692     0.06   0.949     1.01e-06     2518801
```

deprivationV	1.025676	.0214606	1.21	0.226	.9844648	1.068612
IDAOPIV	.1441697	.4224087	-0.66	0.509	.0004623	44.96187
phoneaccessV	1.054014	.9002707	0.06	0.951	.1976081	5.621961
drtwodaysV	.1431628	.2166627	-1.28	0.199	.0073726	2.779965
bookingV	.1166017	.1805105	-1.39	0.165	.00561	2.423513
openinghou~V	5.6657	11.96433	0.82	0.411	.0903151	355.4242
preferGPV	4.32586	4.514897	1.40	0.161	.5593376	33.45576
seventyfiveV	.0000194	.0002897	-0.73	0.468	3.70e-18	1.02e+08
eightyfiveV	306.8741	5798.46	0.30	0.762	2.53e-14	3.72e+18
3						
Sex	.9931966	1.194914	-0.01	0.995	.0939627	10.49821
Age	1.651063	.4593362	1.80	0.071	.9570927	2.848219
Screen_det~d	.9589624	.1327747	-0.30	0.762	.7310499	1.257929
income_dom~n	.9064702	.1007864	-0.88	0.377	.7289743	1.127184
qofC	.649911	.1536774	-1.82	0.068	.4088646	1.033066
qofO	.6614383	.1571873	-1.74	0.082	.4151508	1.053835
qofP	.6462588	.1541708	-1.83	0.067	.4048972	1.031498
qofA	.5712666	.1405807	-2.28	0.023	.3526713	.9253534
qofTotal	1.536919	.3634829	1.82	0.069	.9668092	2.443211
cancerrevV	1.3752	1.537542	0.28	0.776	.1537025	12.30414
cancerprevV	2.25e+26	7.74e+27	1.77	0.077	.0012531	4.05e+55
exceptionr~V	3.199545	4.743671	0.78	0.433	.1750208	58.49067
elderlyV	.0003013	.0036895	-0.66	0.508	1.14e-14	7953106

```
deprivationV |   1.032894   .0337337     0.99   0.322     .9688485    1.101172
     IDAOPIV |   .1488903   .6765975    -0.42   0.675     .0000202    1098.894
phoneaccessV |   .3028384   .3900617    -0.93   0.354     .0242575    3.780724
  drtwodaysV |   1.313511   3.012151     0.12   0.905     .0146708    117.6017
    bookingV |   1.993882   4.856327     0.28   0.777     .0168462    235.9923
openinghou~V |   .4000803   1.349328    -0.27   0.786     .0005387      297.13
   preferGPV |   4.473955   7.423277     0.90   0.367     .1731254    115.6172
seventyfiveV |   79.38125   1967.766     0.18   0.860     6.30e-20    1.00e+23
 eightyfiveV |   .0000457   .0014251    -0.32   0.748     1.39e-31    1.51e+22
-------------+----------------------------------------------------------------
4            |
         Sex |   .1872778   .1711265    -1.83   0.067     .0312388    1.122738
         Age |   3.279158   1.175869     3.31   0.001     1.623795    6.622066
Screen_det~d |   .8262845   .1509909    -1.04   0.296     .5775446    1.182153
income_dom~n |   1.235724   .1855905     1.41   0.159     .9206229    1.658676
        qofC |   .7120157   .2367359    -1.02   0.307     .3710873    1.366164
        qofO |   .7156713   .2371931    -1.01   0.313     .3737679     1.37033
        qofP |   .7011549   .2327711    -1.07   0.285     .3657886    1.343996
        qofA |   .6054272   .2097591    -1.45   0.148     .3070087    1.193914
    qofTotal |   1.421552   .4718357     1.06   0.289     .7417122    2.724521
  cancerrevV |   .0667087   .0867535    -2.08   0.037     .0052145    .8534049
 cancerprevV |   9086.923   391630.1     0.21   0.833     1.88e-33    4.40e+40
exceptionr~V |   1.675207   2.951767     0.29   0.770     .0529937    52.95565
    elderlyV |   1.78e+16   2.84e+17     2.35   0.019     490.4599    6.47e+29
```

deprivationV	.9872644	.0421488	-0.30	0.764	.9080161	1.073429
IDAOPIV	21.24511	120.3052	0.54	0.589	.0003215	1404034
phoneaccessV	370.0995	741.5229	2.95	0.003	7.292403	18783.06
drtwodaysV	.0348653	.1025248	-1.14	0.254	.0001095	11.10284
bookingV	.0124664	.0343478	-1.59	0.112	.0000563	2.760572
openinghou~V	6.168556	26.53554	0.42	0.672	.0013444	28303.01
preferGPV	5.577499	11.51288	0.83	0.405	.0975931	318.757
seventyfiveV	6.09e-37	1.98e-35	-2.57	0.010	1.40e-64	2.65e-09
eightyfiveV	5507690	2.39e+08	0.36	0.721	5.67e-31	5.35e+43
unknown						
Sex	5.49e+07	2.78e+08	3.52	0.000	2668.657	1.13e+12
Age	6.292905	1.869182	6.19	0.000	3.515755	11.26377
Screen_det~d	1.509153	.2433171	2.55	0.011	1.100262	2.070001
income_dom~n	1.18405	.1329697	1.50	0.132	.9501222	1.475573
qofC	.9666175	.2185809	-0.15	0.881	.6205442	1.505694
qofO	.9801672	.222181	-0.09	0.930	.6285686	1.528437
qofP	.9740085	.221844	-0.12	0.908	.6232895	1.522074
qofA	.9708884	.233988	-0.12	0.902	.6053776	1.557085
qofTotal	1.025867	.2322264	0.11	0.910	.6582693	1.598741
cancerrevV	.6628693	.7179905	-0.38	0.704	.0793312	5.538748
cancerprevV	1.20e+28	3.98e+29	1.95	0.051	.7595678	1.90e+56
exceptionr~V	.0220089	.0589841	-1.42	0.154	.0001152	4.205629
elderlyV	34.95883	400.1086	0.31	0.756	6.33e-09	1.93e+11

deprivationV	1.03265	.0328202	1.01	0.312	.9702862	1.099022
IDAOPIV	.005278	.0232689	-1.19	0.234	9.33e-07	29.86107
phoneaccessV	.2359499	.3254563	-1.05	0.295	.0158023	3.523061
drtwodaysV	.7553746	1.781011	-0.12	0.905	.0074338	76.75612
bookingV	.9794039	2.441156	-0.01	0.993	.007402	129.5909
openinghou~V	2.337383	7.831273	0.25	0.800	.0032872	1662.012
preferGPV	19.11772	31.77197	1.78	0.076	.7358921	496.6587
seventyfiveV	6.63e-16	1.54e-14	-1.50	0.133	1.06e-35	41580.97
eightyfiveV	2.06e+08	6.22e+09	0.63	0.526	4.34e-18	9.79e+33